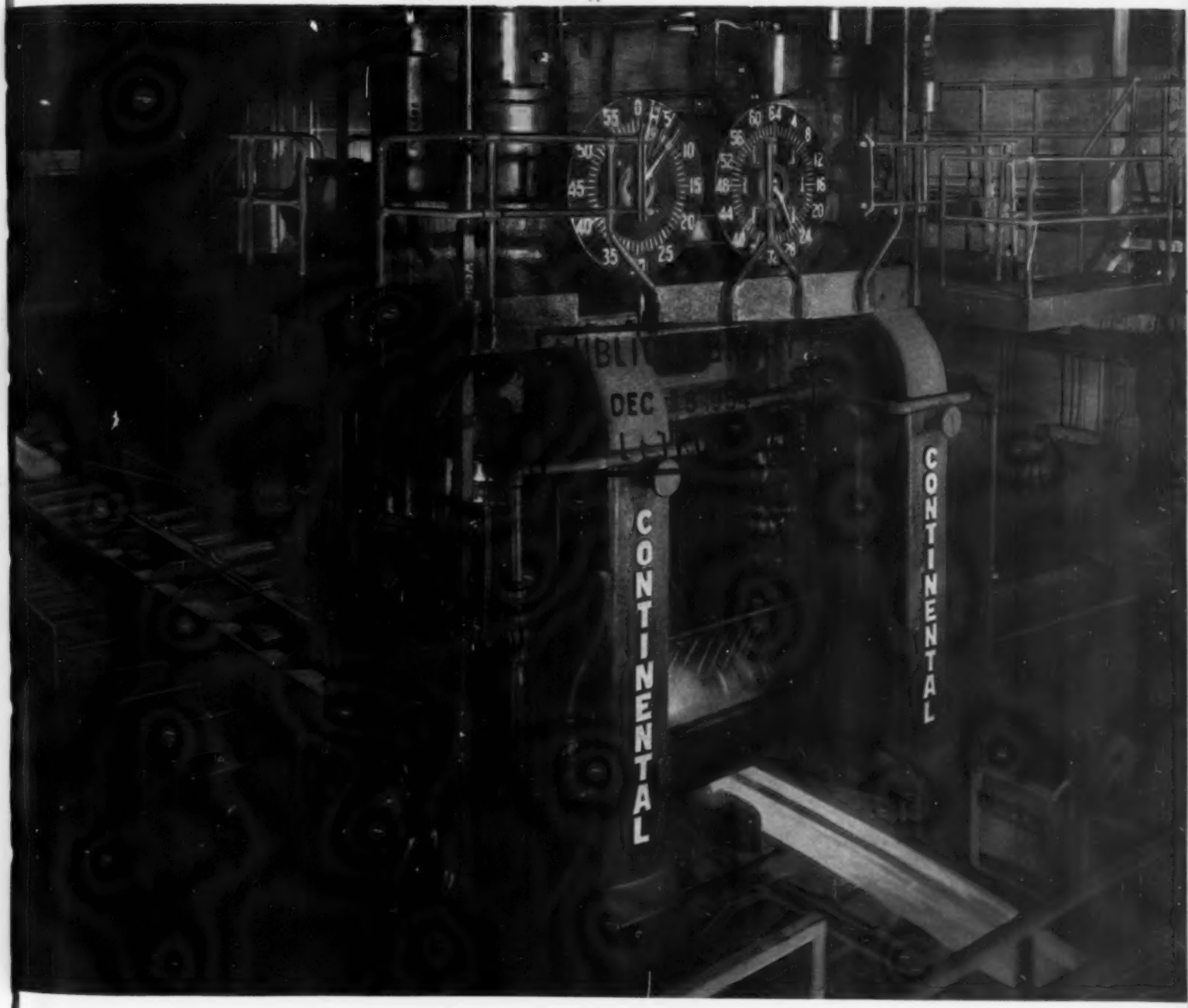
Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

DECEMBER, 1954 TECHNOLOGY DEPT. TABLE OF CONTENTS, PAGE 53

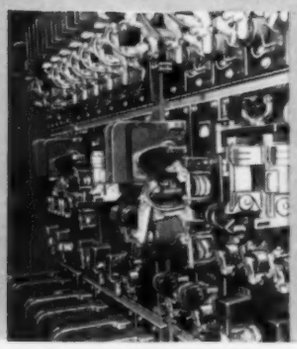


Continental Mill Rolls Wide Flanged Beams

Plants at
East Chicago, Ind. • Wheeling, W. Va. • Pittsburgh, Pa.
Copes-Vulcan Division, Erie, Pa.

CHICAGO · PITTSBURGH

CONTINENTAL
Foundry & Machine
Company



TONNAGE

inside a cordon of safety.

The Cutler-Hammer story at the Fairless Docks

TONNAGE—moving inside a cordon of safety—is the picture here at Fairless ore docks. The two unloaders and one ore bridge can move a total of 3400 net tons of ore per hour, free digging. The trolleys travel at speeds up to 1000 feet per minute. Here, Cutler-Hammer applied its unique and exclusive Wilson-Ritchie emergency dynamic braking control. Also furnished on the trolleys is Cutler-Hammer's "Speed-Distance" end zone protection. Each hoisting line is further protected against over-hoisting of the bucket and excessive cable pay-off. Interlocking between the control and an anemometer panel prevents operation of the rigs in unfavorable wind conditions. Both power and control automatic over-skew protection is provided for the travel motion of the ore bridge.

"FABULOUS" IS THE WORD

to describe the new U. S. Steel Fairless Works. The entire mill represents engineering thought carried to the perimeter of development and discovery. And anybody who follows *that* thought through to its logical conclusion will know why the name that appears on the motor control for the ore unloaders and ore bridge is Cutler-Hammer. It is *NOT* strange coincidence that puts Cutler-Hammer Control on so many outstanding achievements in so many divisions of the steel and metal industry. It is the fact that Cutler-Hammer has pioneered and blazed new trails since 1892. That C-H has amassed tremendous control engineering knowledge. That C-H engineering thought is the *break-away* and *break-through* type that goes straight-line to sure and sound solutions that mean dependability, productiveness, profit. All this knowledge and experience is available to you . . . at any time, whether for a proposed installation or an existing troublesome application in your mill. Look to Cutler-Hammer for experience as broad as it is long. CUTLER-HAMMER, Inc., 1269 St. Paul Avenue, Milwaukee 1, Wisconsin. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto, Ont.

CUTLER·HAMMER
MOTOR CONTROL
C-H

LOOK TO CUTLER-HAMMER MILL EXPERIENCE...AS BROAD AS IT IS LONG

IRON AND STEEL ENGINEER: published monthly by Association of Iron and Steel Engineers, 1010 Empire Bldg., entered as second class matter January 25, 1924 at Pittsburgh, Pennsylvania, under Act of Congress, March 3, 1879 $7.50 per year in United States and Canada, $10.00 foreign countries. Volume 31, No. 12

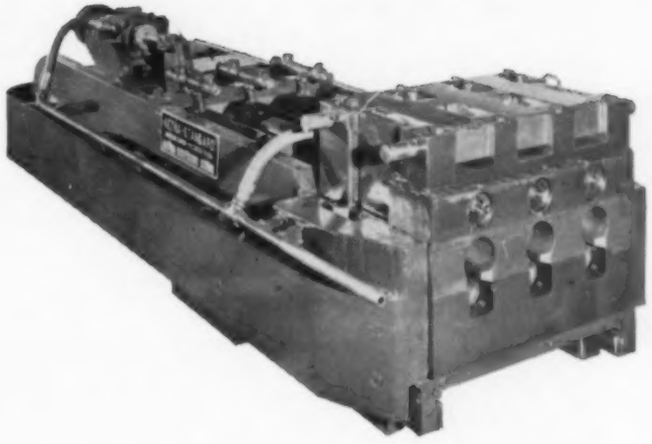
announcing . . .

NEW DRAWBENCH DEVELOPMENT

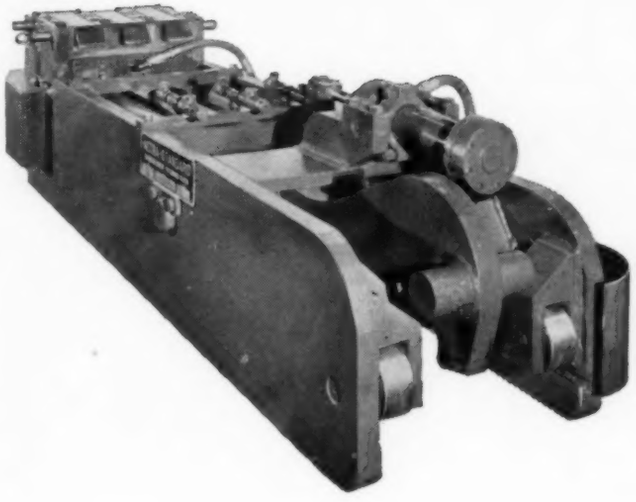
AIR

OPERATED CARRIAGES

AND HOOK



● Says an Aetna drawbench customer—"Applying air to the carriages and hook is the greatest thing you have ever done for me."



Aetna has equipped ten benches with air-operated carriages and hook. What about yours?

positive gripping . . .
positive hooking . . .

● Tubes can be drawn at least six inches before air pressure releases the gripping cylinders. This six-inch margin assures a positive grip on tubes. Another advantage — the use of air permits close-up gripping to die stand although the carriage action does not require actual contact with die stand.

Both the carriage and air hook cut down on breakage and maintenance because they eliminate the chief cause — slam-bang action. The cylinder lets the hook down gently and smoothly.

Air-operated carriages, which include many patented features, can be adapted to existing benches of any size. Aetna has interchangeable heads for Aetna's own benches or can adapt the new head to existing benches of other makes. The air-operated heads and hooks can be used for single, double, triple, four- or five-draw.

THE AETNA-STANDARD ENGINEERING COMPANY • PITTSBURGH, PA.

Aetna-Standard

PLANTS IN WARREN, OHIO • ELLWOOD CITY, PENNSYLVANIA

GOOD EQUIPMENT BRINGS DOWN PRODUCTION COSTS

SUBSIDIARY and ASSOCIATED COMPANIES

Head Wrightson Machine Company, Ltd., Middlesbrough, England — Great Britain, Finland, Sweden, Norway, Denmark, Union of South Africa, Northern and Southern Rhodesia.
Aetna-Standard Engineering Company, Ltd., Toronto, Ontario, Canada.
M. Castellvi, Inc., New York, N. Y. — Mexico, Central and South America.
Societe de Constructions de Montbard, Paris, France — France, Belgium, Holland, Luxembourg, Switzerland.
Demag Aktiengesellschaft, Duisburg, Germany — Germany, Austria, Yugoslavia, Greece, Turkey, Egypt.
Compagnia Italiana Forme Acciaio, Milano, Italy — Italy.
Aetna-Japan Company, Ltd., Tokyo, Japan — Japan.
Hale & Kulgren, Inc., Akron, Ohio — Representative for the Rubber Industry.
Standard Engineering Company, Ellwood City, Pa.
Trans-World Traders, Pittsburgh, Pa.

Designers and Builders to the Ferrous, Non-Ferrous, Leather, Rubber, and Plastic Industries

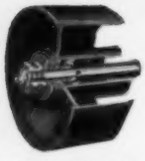
7 solid reasons why it pays to standardize on LINK-BELT IDLERS

1 STRONG, RIGID FRAMES support rolls in perfect alignment. Rolls are securely held in place but can be easily removed for inspection and service.

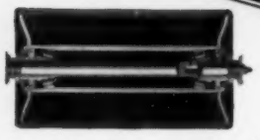
2 CONCENTRIC ROLLS have smooth surfaces and rounded edges. Machine-made, continuous welds prevent entrance of dirt and moisture—assure hop-free rotation.

3 HUSKY, HIGHEST QUALITY BEARINGS, free and easy turning, provide concentricity and perfect alignment for smooth operation, minimum belt wear, low power requirements.

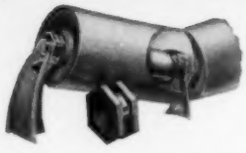
4 SAFE, CONVENIENT GREASE FITTINGS provide ease of lubrication. Extensions can be furnished for greater accessibility in out-of-the-way locations.



5 POSITIVE, COMBINATION GREASE SEAL unit retains lubricant, prolongs bearing life. The most effective seal offered in idlers today!



6 ROLLS consist of a counterbored outer shell plus a full-length, heavy central tube of 3/16-in. steel. Both tube and shell are welded to dished steel heads to maintain balance and bearing alignment.



7 HEX NUTS provide bearing adjustment at shaft ends and prevent rotation in service. Nuts prevent bracket from spreading under unusual impact.

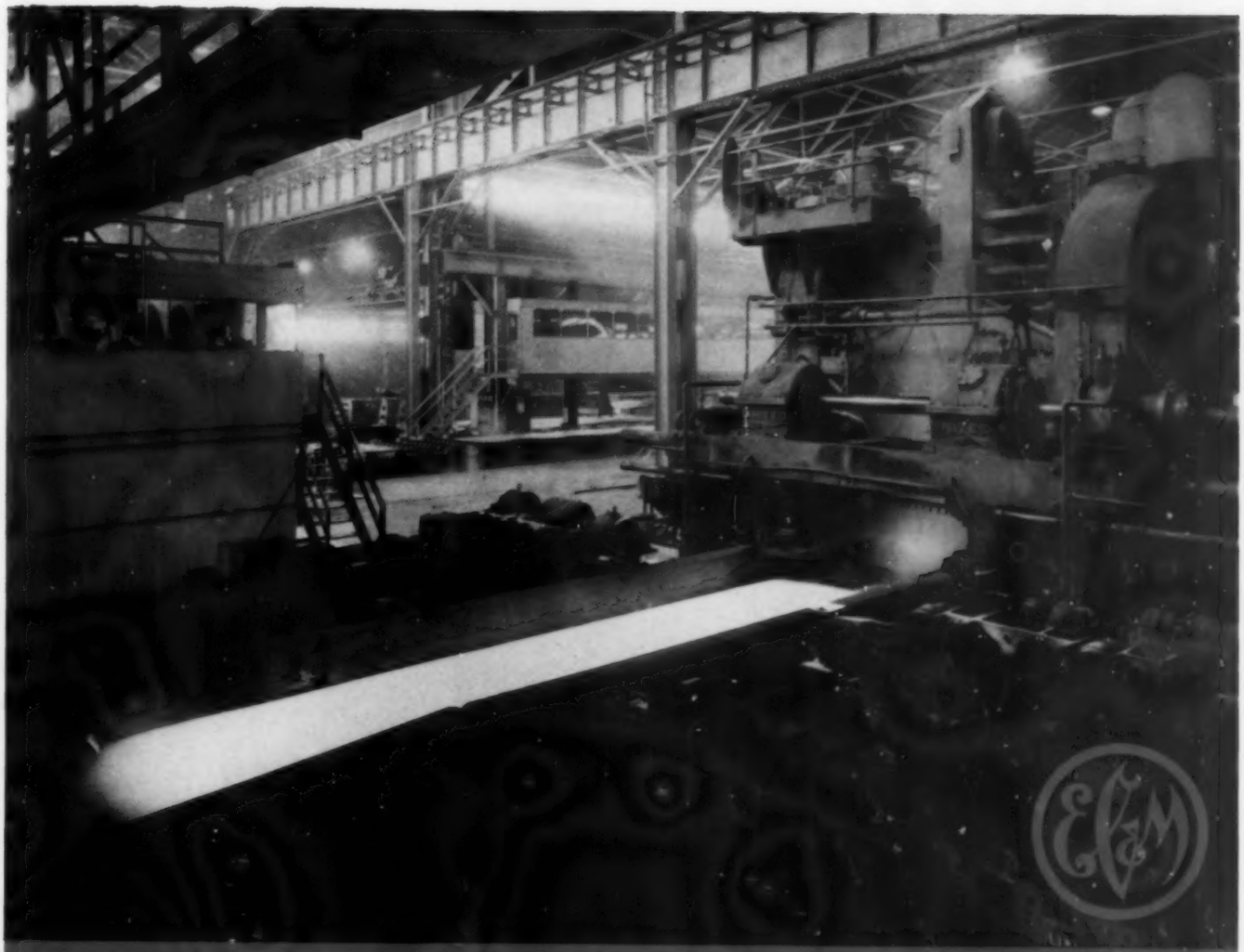
Get the right idler from industry's most comprehensive line

Link-Belt makes more than 500 belt conveyor idlers in 34 types. You can select from light, medium or heavy-duty 20° troughing idlers, two types of 45° idlers, flat belt, belt training, rubber cushion and the new Link-Belt variable troughing idler. Most are built in a broad range of roll diameters and belt widths with matching return idlers. Ask your Link-Belt sales representative or distributor for new 48-page Book 2416.

LINK-BELT

BELT CONVEYOR IDLERS

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office: New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 19.415



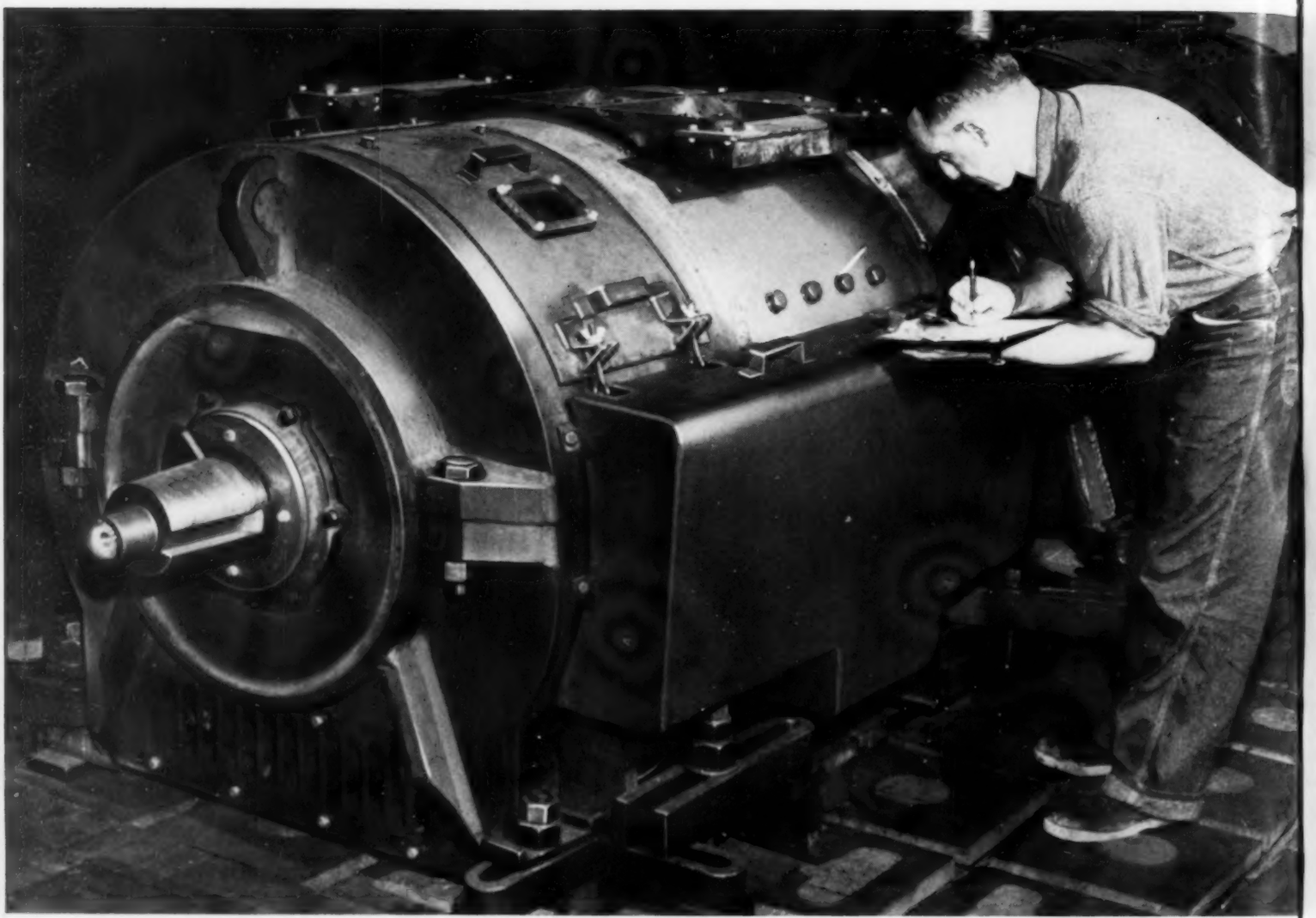
Pre-Set Rolling of Plates With EC&M Automatic Screwdown Control. Screwdowns, edgers, and sideguards move to exact rolling dimensions automatically under single push-button operation. Operator is stationed in enclosed, elevated pulpit with clear view of all operations in this large, 120-inch plate mill. This simple EC&M control is used in several mills throughout the United States, resulting in improved product, faster rolling with extreme accuracy.

Like An Organ Player, The Operator Rolls Steel from button-panel using schedule No. 1 while an assistant prepares schedule No. 2 for a change in rolling requirements.

Also In This Same Plant Is The World's Largest Plate Mill (shown above). It has been EC&M controlled for many years.

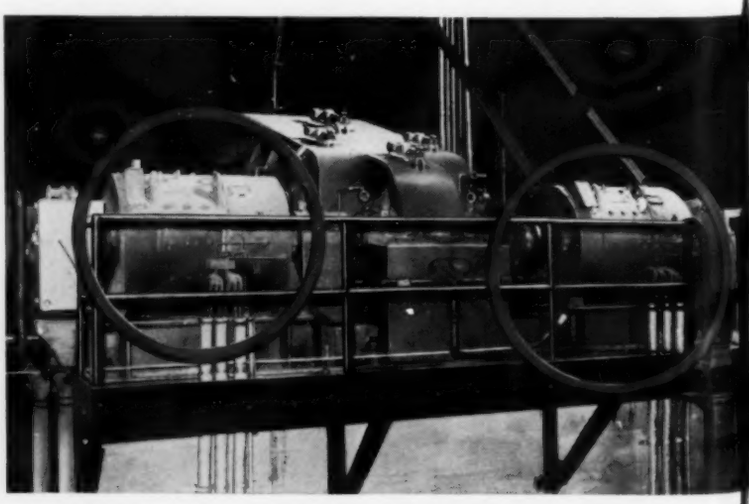
THE ELECTRIC CONTROLLER & MANUFACTURING COMPANY, 2698 East 79th St., Cleveland 4, Ohio

NEW G-E Armored Mill Motor—



TO ASSURE YOU of dependable service, this MD-622 is undergoing the rigid tests given to all G-E Armored Motors before shipment.

POWER SHOVEL equipped with compact G-E Type MD motors which have high overload capacity and the ability to take the terrific shocks of excavating duty.



SLAB SHEAR in reversing, blooming and slabbing mill is typical of severe applications in the steel industry that are dependably powered by G-E armored motors.

Most Powerful in its Class

Another G-E "first"—the MD-622—gives you more horsepower and torque than any other mill motor!

POWER-PLUS for the toughest heavy-duty application—that's the job of the MD-622—General Electric's latest addition to the MD-600 Armored Motor line.

AISE OBJECTIVES set up for smaller motors of this type, are met in the construction of the MD-622, which gives you more horsepower, increased commutating ability and better speed regulation in the same mounting dimensions as the earlier motor. Designed for duty in steel mills, power shovels, mine operations, dredges and ore bridges, it's ideal for extra torque, high momentary loads and snappy reversals.

RATED 500 HP AT 350 RPM when force ventilated, this motor delivers more torque relative to its size than any other mill motor ever built.

BETTER SPEED REGULATION can be maintained at higher speeds than in previous motors—and maximum safe speed is 20% higher.

WIDER SPEED RANGE is possible with the adjustable speed MD-622 and stabilizing series windings are not required, simplifying control on reversing operations.

REDUCED MAINTENANCE due to integral feet on armature. Out of frame, it stands by itself. Armature spider allows replacement of shaft without disturbing windings.

FOR NEW BULLETIN on MD-600 motors, fill out the coupon below. If you need more information, contact your nearest G-E Apparatus Sales Office. General Electric Co., Schenectady 5, N. Y.

Please send Bulletin GEA-4654C, "DC Armored Motors," which gives the complete story on the MD-600 line with examples of their reliable performance throughout industry.

General Electric Co.
Section K810-3
Schenectady, N. Y.

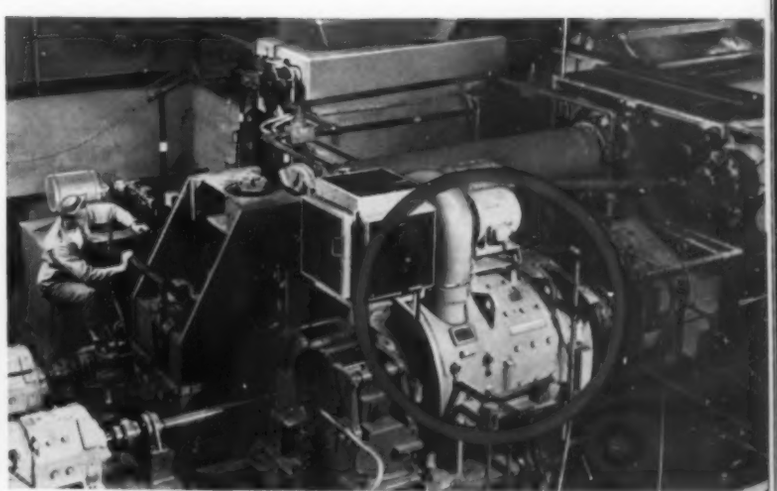
☐ Planning an immediate project.
☐ For reference only.

NAME .....
COMPANY .....
ADDRESS .....
CITY ..... STATE .....

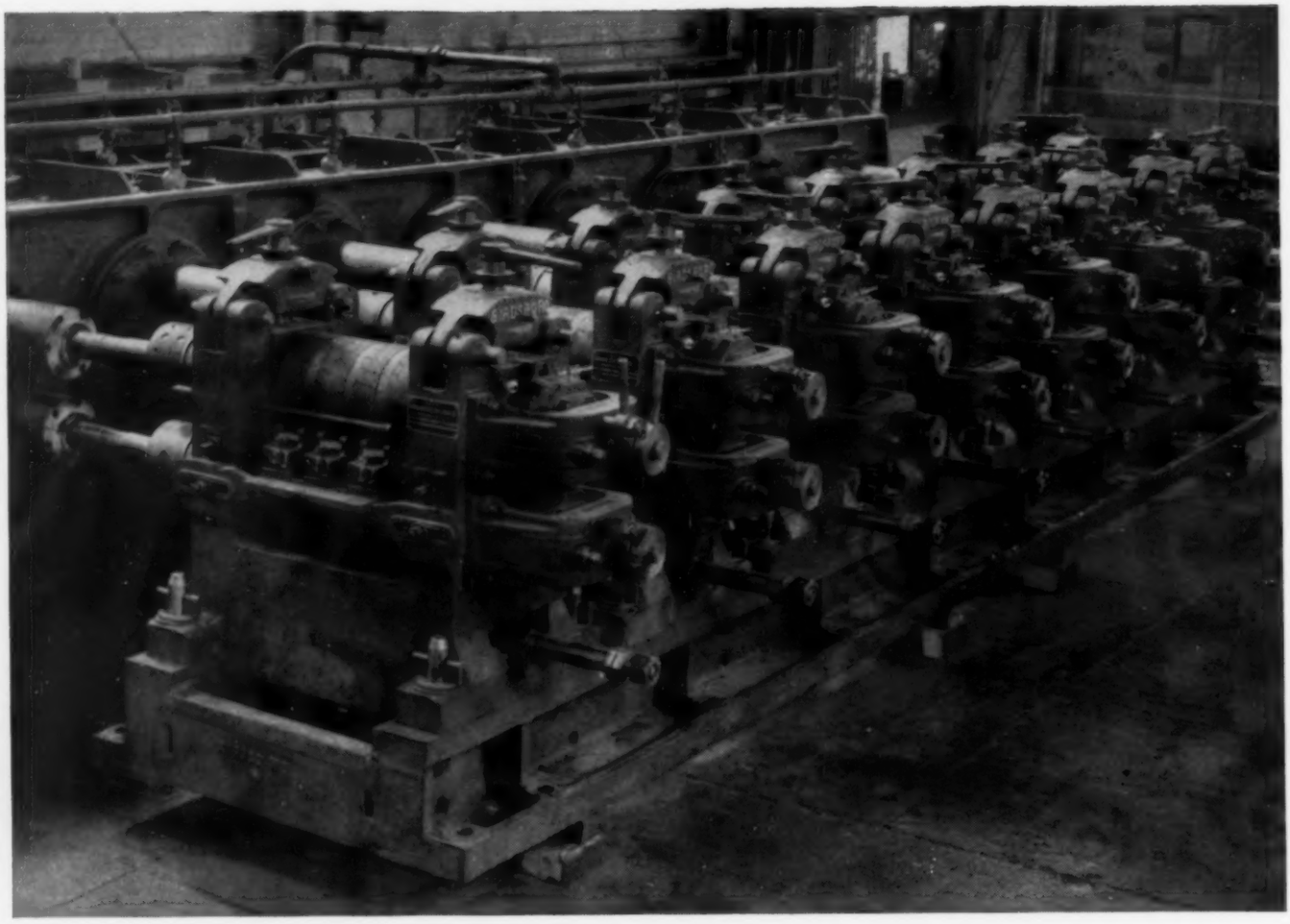
Progress Is Our Most Important Product

GENERAL ELECTRIC

DRAGLINE powered by amplidyne-controlled G-E armored motors—which were selected because of their high torque and quick reversing characteristics.



COILER in hot strip mill driven by force ventilated G-E armored motor with extra horsepower and mechanical strength to withstand severe operating conditions.



MODERNIZE YOUR ROD MILL

for Increased Production... Lower Costs

Birdsboro's advanced engineering developed a new high speed finishing train, coilers and conveyors to modernize an existing mill. The eight stand finishing train is shown above at shop assembly.

If your production is lagging—or you find operating and maintenance costs are top heavy, call on Birdsboro. We are well equipped and have the engineering skill to modernize existing equipment—or replace it with the most up-to-date, efficient steel mill machinery.

Designers and Builders of:

STEEL MILL MACHINERY
HYDRAULIC PRESSES
CRUSHING MACHINERY
SPECIAL MACHINERY
STEEL CASTINGS
Weldments "CAST-WELD" Design
ROLLS: Steel, Alloy Iron, Alloy Steel

MM-21-51-R

BIRDSBORO

BIRDSBORO STEEL FOUNDRY & MACHINE CO., BIRDSBORO, PENNA. Offices in Birdsboro, Pa. and Pittsburgh, Pa.

A STUDY of ALUMINUM SHEET ANNEALING

Fabricators of aluminum sheet products that require severe forming or deep drawing are familiar with the drawbacks of using material with irregular grain structure and/or a heterogeneous hardness pattern. Excessive grain size appears in the form of "orange peel" effect, and when directional properties are not closely controlled, "earing" is apt to occur.

The "orange peel" detracts from the product finish and requires costly secondary operations to remove, and above normal "earing" means excessive scrap with frequently an extra trimming operation.

Photograph illustrates seven types and shapes of drawn aluminum alloy cups exhibiting varying degrees of ears.

SCOVILL MANUFACTURING CO. LEADS THE WAY

Two years ago the Scovill Manufacturing Co., Waterbury, Conn., a producer of aluminum sheet since 1889, in anticipation of future requirements of industry, set into operation an aluminum annealing system that was the result of years of planning and experimentation. They wanted to provide a sheet with exceptional uniformity of physical properties and grain structure with an especially fine finish. And, they wanted to offer this strip in extra-long coils.

Scovill studied all existing methods of annealing and selected the Lee Wilson Bell Type Radiant Fired "O" Tube Furnace with Controlled Nitrogen Atmosphere as the equipment best suited to do the job.

Photograph illustrates varying degrees of "orange peel" effect.

In 1952 the installation was completed. It comprises two furnaces and six bases. Each furnace is equipped with 12 Lee Wilson "O" tubes with a total input of 3,600,000 BTU per hour at maximum fire rate. To get the most effective heat transfer possible, Lee Wilson convector plates are placed between stacked coils of the charge.

WILSON FURNACES ARE FAST

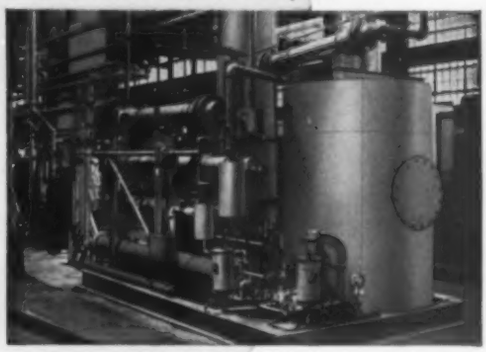
A study of coil size requirements resulted in a base which can load three stacks of 36" diameter coils with a piling height of approximately 60" net per load. In determining piling height, deformation and sticking of bottom coil edges were considered. Large coil requirements were considered in designing furnace diameters. With full charges of coils large enough to utilize convector plates, production per furnace with three bases is about 2500 lbs. per hour, or 5000 lbs. per hour for the installation.

NITROGEN ATMOSPHERE USED

For the first time in the history of aluminum annealing, nitrogen atmosphere is used. By keeping oxygen away from the aluminum during the annealing cycle, the formation of surface oxides is eliminated. The natural aluminum finish is retained.

What have Scovill and its customers to say about this controlled annealing? "We are getting," say Scovill officials, "sheet with controlled grain sizes, tempers, directional properties and dimensions far closer than once was thought possible. The control we can exert over the charge with the bell type furnace and regulated high input firing tubes in an oxygen-free atmosphere enables us to produce sheet of exacting grain structure and hardness with perfect uniformity throughout the entire charge."

Scovill has received glowing commendations from its customers which substantiate the above statement. Scovill calls this "new" aluminum sheet Truspec.



Generator which produces dry nitrogen atmosphere for the annealing process. A product of Gas Atmospheres, Inc., a Lee Wilson enterprise.

GET THE COMPLETE STORY

If you are in the business of producing aluminum or any non-ferrous or ferrous metal in strip, sheet, coil or wire and rod forms, check first with a Lee Wilson engineer before you buy annealing equipment.

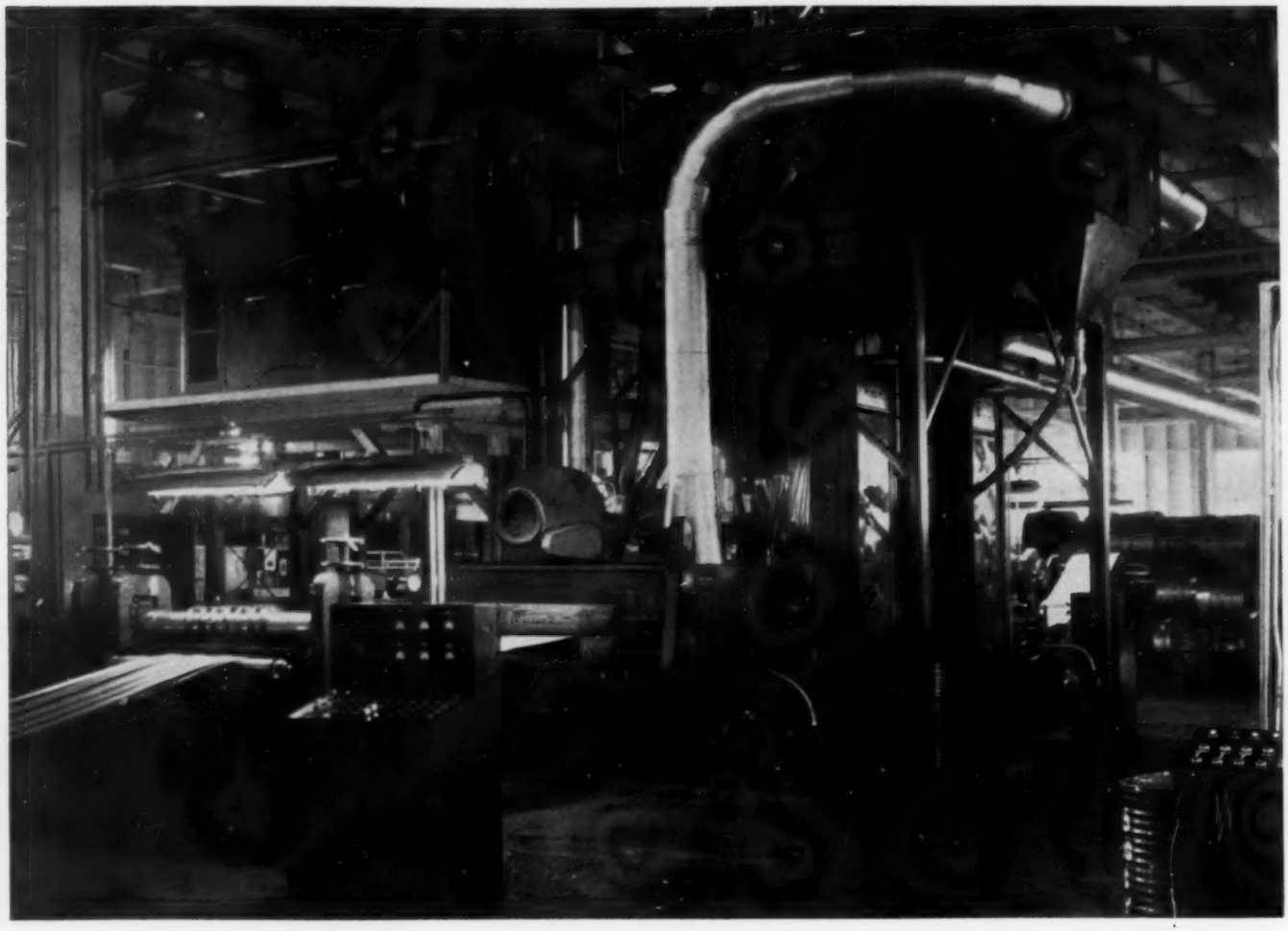
Typical full charge of 36" diameter aluminum coils with convector plates in place.

Comprehensive view of the Scovill annealing installation of Lee Wilson bell type furnaces of the high convection type.

Lee Wilson Engineering Company • Inc.

20005 West Lake Road • Cleveland 16, Ohio

pioneering developments keep WHEELABRATOR® first in blast cleaning



8 Steps to Low Cost Cleaning of Steel Mill Products

Wheelabrator Mechanical Cleaning SAVES Time and Money—Eliminates Acid Handling and Disposal Problems

If you have any of these finishing problems, Wheelabrator Mechanical Cleaning can save time, money and space and improve your operations:

1. Ingot Mold Conditioning
2. Slab and Billet Conditioning
3. Continuous Strip Descaling
4. Sheet Descaling
5. Bar Stock Descaling
6. Wire Rod Descaling
7. Steel Shapes Descaling
8. Etching Mill Rolls

New developments in Airless Wheelabrator blast equipment and abrasives have eliminated all past objections to blast cleaning with an attendant reduction in costs. These have been proved lower than present pickling costs by the many Wheelabrator installations on all types of steel products.

With the Wheelabrator, scale is uniformly and economically removed leaving a surface ideal for cold rolling, cold forming, cold drawing and final finishing such as galvanizing or painting. By eliminating completely or partially the use of acid pickling, the Wheelabrator can equal or better your present costs without any virgin metal loss and with complete recovery of all scale as well as the abrasives used in its removal. Acid disposal problems are eliminated.

These impressive savings are being effected for steel producers and fabricators alike. Rome Cable Corp., for example, selected Wheelabrating for descaling steel strip because it was the only process that would remove surface scale economically and permit the rest of the plant to maintain its high production without requiring a major portion of its plant area.

Write today for complete information on this modern method of steel finishing for your problem.

Bulletin 894 describes the descaling of Steel Strip and Bulletin 914 describes the descaling of steel sheets. Send for your copies today.

American

WHEELABRATOR & EQUIPMENT CORP.

396 S. Byrkit St., Mishawaka, Ind.

Wheelabrator®
AIRLESS BLAST CLEANING

THIS WF WIRE FLATTENING TEAM

. . . SQUEEZES "DOWN-TIME", TOO

Close-up of a Waterbury Farrel winder at the delivery end of a WF Tandem Mill. Winder is provided with pneumatic clamping of reels. It has three adjustments for width of wire and width and positioning of drum or spool.

This complete Waterbury Farrel mill package includes 10" and 8½" Tandem Wire Flattening Mills, power driven double head Pay-off, Edger, Winder, footage counter, continuous thickness and width gauges and automatic electrical synchronizing control. Other WF tandems with up to five mills available.

Modern Waterbury Farrel Mill Design Insures High Production Plus Precision . . . Minimizes "Down-Time"

Here are some reasons why Waterbury Farrel Wire Flattening equipment can give you *more continuous,* high speed, precision production.

- Loading payoff and motor driven screwdowns for mills and edgers facilitate threading of wire with minimum effort and time.
- To protect precision operation, soluble oil is circulated internally and externally on the rolls and into coolant enclosures where wire is submerged. A refrigeration system maintains the coolant oil temperature at approximately 70° while a flotation unit keeps it clean and fresh. In addition, high speed mills also have a self-contained, automatically-filtered circulating mineral oil lubrication system for roll necks and drives.
- Transparent lucite covers at vital lubrication points such as gear cases and universal joints make it easy to check lubrication at a glance.
- Anti-friction bearings are used for all rotating members including the winder shaft. High precision anti-friction bearings are used on roll necks and edger arbors. This, combined with precision fitting of component parts enables WF mills to maintain tolerances well inside commercial allowance.
- Tungsten carbide ring rolls permit rolling the toughest alloys and increase roll life.
- Electric control keeps wire tension constant. Dancer rolls are used for fine wire.

Waterbury Farrel designs and builds a wide range of wire flattening mill equipment to suit specific requirements. Various sizes and combinations of single and multiple mill stands with auxiliary equipment are available for flattening ferrous and non-ferrous wire from the smallest diameters to 1" diameter and more. Speeds range up to and above 2500 FPM.

Write for further information.

WATERBURY FARREL FOUNDRY & MACHINE CO.
WATERBURY 20, CONN.
***Sales Offices:* Chicago, Cleveland, Millburn, N. J.**

WATERBURY FARREL FOUNDED 1851

A FEW OF THE MANY TYPES OF METAL WORKING MACHINERY MADE BY WATERBURY FARREL

MILL MACHINERY—Rolling Mills: Strip, Rod, Wire Flattening, (For Ferrous and Non Ferrous Metals) • Also Slitters • Straighteners • Cut-off Saws • Coilers • Winders, etc. *WIRE MILL EQUIPMENT*—Continuous Wire Drawing Machines (Upright Cone and Tandem) • Wire Flattening Mills • Chain Draw Benches • Pointers Swagers • Bull Blocks • String-up Machines • Spoolers, etc. *COLD PROCESS BOLT & NUT MACHINERY*—Headers (all types) • Rivet Machinery • Trimmers • Thread Rolling Machines • Slotters • Nut Formers and Tappers, etc. *POWER PRESSES*—Crank, Cam and Toggle; also Rack and Pinion Presses • Eyelet Machines Multiple Plunger Presses • Horizontal and Hydraulic Presses, etc.

WF 9

It's Time to

MODERNIZE

ALLIS-CHALMERS

PROGRESS IN

Switchgear

Allis-Chalmers unit substations improve safety . . . save space . . . improve appearance. They are easy to specify and easy to install.

Metal-clad switchgear provides safe, compact control and circuit protection. Special circuit schemes in standard structures can be provided to assure uninterrupted power.

Individually enclosed low voltage air circuit breakers like this have wide application in industry for protection of motors, lighting circuits, and transformers.

ALLIS-

ELECTRICALLY

with Allis-Chalmers Switchgear

when voltage is low

Low voltage at motors is usually caused by overloaded feeders or long runs of low voltage cable. Undervoltage reduces motor torque; increases production time on machine tools; increases time required by heating elements.

when space is limited

Older types of switchgear often use critical production floor space. Replace with compact Allis-Chalmers switchgear. It fits anywhere . . . on the roof . . . on a balcony . . . in the basement . . . or outside near the building.

when cable runs are long

Long low voltage cable runs are wasteful. Savings realized by elimination of long low voltage feeders include cable cost, installation cost and cost of power lost. These savings alone will often justify modern Allis-Chalmers load center unit substations.

when relocation costs are high

Equipment relocation costs are sometimes excessive. Savings in relocation costs due to product changes or production modifications can be made by using Allis-Chalmers switchgear, bus duct and unit substations. Everything is salvageable!

when automation is used

If automation or other continuous processing is used, power interruptions cannot be tolerated. Standard Allis-Chalmers metal-clad switchgear is designed to accommodate special circuit schemes, such as ring bus and transfer bus, to assure uninterrupted flow of power.

when load growth is fast

System capacities now exceed breaker ratings in many plants. Breakers have become obsolete due to increased use of power. These breakers may be inadequate to handle a short circuit, with resulting possible danger to plant personnel and equipment.

Let experienced Allis-Chalmers switchgear engineers help you solve your distribution problems. Call your nearby Allis-Chalmers district office, or write Allis-Chalmers, Milwaukee 1, Wisconsin.

Allis-Chalmers
Milwaukee 1, Wis.

Please send me New Load Center Substation Booklet 11B6285B.

Name .....

Title .....

Firm .....

Street .....

City ..... State .....

A-4247

A-C ALLIS-CHALMERS

CHALMERS

HAGAN
Air-Operated Controls

Accurate, Dependable

Every advance toward better combustion efficiencies in the steel industry has demanded higher quality in automatic control and instrumentation. Hagan equipment and Hagan methods have consistently held the leadership in solving the problems involved. Many new practices have succeeded largely through the contributions made by Hagan engineers in the design, development and application of Air-Operated Controls and Ring Balance Instruments.

Each unit of a Hagan system of Automatic Control or Instrumentation is designed to perform its specific functions accurately, and to coordinate smoothly with all other components of the system. Adjustments of ample number and range are provided. Special care is taken in the design to assure long life, with minimum maintenance costs.

The applications listed on the opposite page emphasize the versatility of Hagan designs.

Make Hagan Automatic Controls and Instrumentation the choice for your next installation, whether modernization, extension or new construction.

HAGAN CORPORATION

HAGAN BUILDING • PITTSBURGH 30, PA.

Boiler Combustion Control Systems • Ring Balance Flow and Pressure Instruments • Metallurgical Furnace Control Systems • Control Systems for Automotive and Aeronautical Testing Facilities

HAGAN
HALL
BUROMIN
CALGON

HAGAN

Ring Balance Instruments

. . . . and versatile

blast furnaces

Blower delivery control on volumetric or constant weight basis
Pressure and temperature compensated air flow meters
Air distribution control
Bleeder valve control
Gas distribution metering and control
Flow meters for water, steam
Stove burner gas input and gas-air ratio control

coke ovens

Exhauster and booster controls
Collecting main pressure control
Stack draft control
Underfiring gas pressure control
Flow and draft recorders
Millimeter gauges

open hearth and heating furnaces

Total heat input control and fuel-air ratio control for single or multiple fuels
Furnace pressure control
Oxygen flow metering and control
Reversal control
Btu meters for gas firing
Draft and pressure recorders
Flow metering for steam, oil, gas or water

soaking pits

Fuel input control
Fuel-air ratio control
Reversal control
Gas pressure control
Furnace pressure control
Waste gas flue draft control
Draft and pressure recorders
Flow metering for steam, oil, gas or water

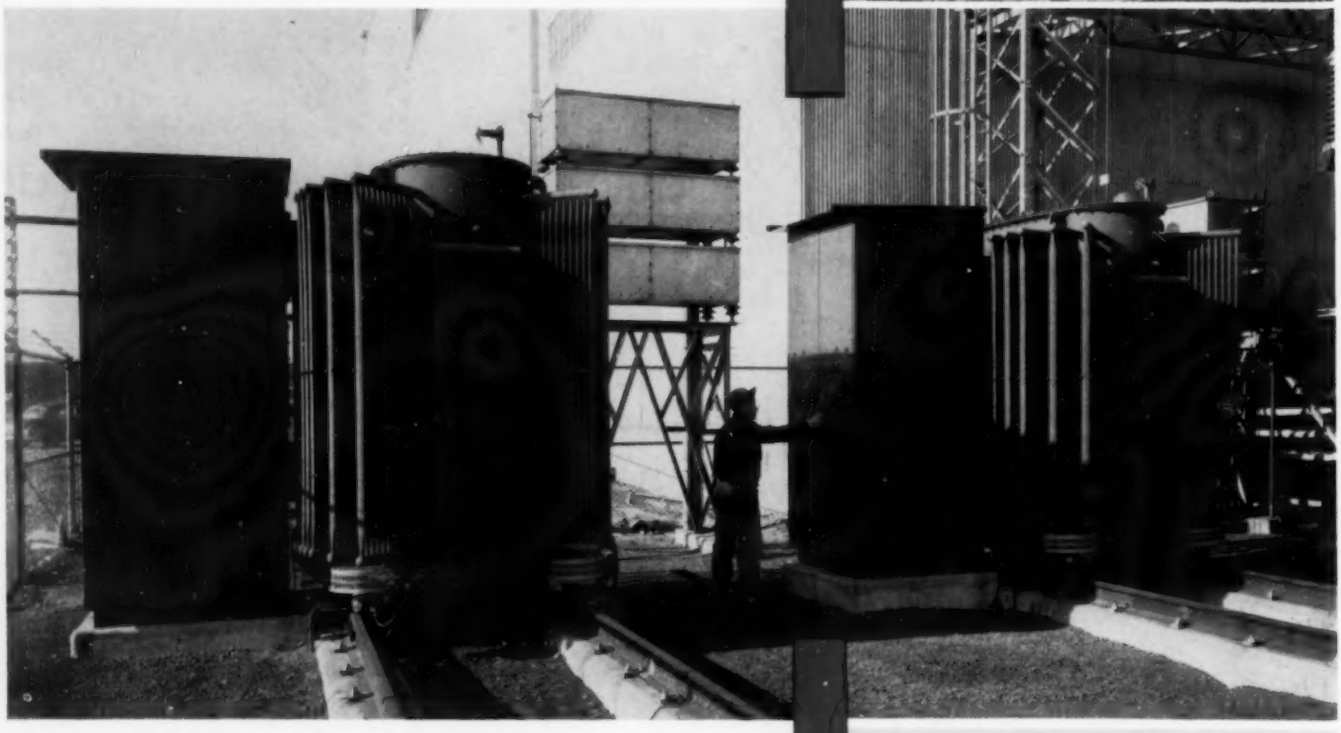
gas distribution systems

Gas mixing stations
Gas pressure control
Sequential distribution control
Pressure stabilization control
Gas flow meters—with automatic compensation for pressure and temperature
Btu meters

boiler houses

Steam pressure control
Automatic control of single or multiple fuel input, firing separately or simultaneously
Control of load distribution
Fuel-air ratio control
Furnace draft control
Boiler drum water level control
Flow metering for steam, oil, gas and water
Automatic compensation of flow readings for pressure and temperature variations
Pneumatic and electric signal transmission

23 PENNSYLVANIA UNIT SUBSTATION TRANSFORMERS feed all 2400 volt lines at United States Steel's Fairless Works



19 — 2500 Kva and 4 — 3750 Kva Pennsylvania Transformers are supplying power at 2400 volts to operate open hearth furnaces, blast furnaces, hot and cold rolling mills, and coke ovens at the famous Fairless Works. Functioning as important components of I-T-E Unit Substations, these Pennsylvania Transformers assure an uninterrupted flow of power from the 13,800-volt power system to the 2400-volt distribution system.

Pennsylvania Transformer Company manufactures a complete line of power and distribution transformers, 3 Kva through 300,000 Kva, in voltages up to 330,000 volts.

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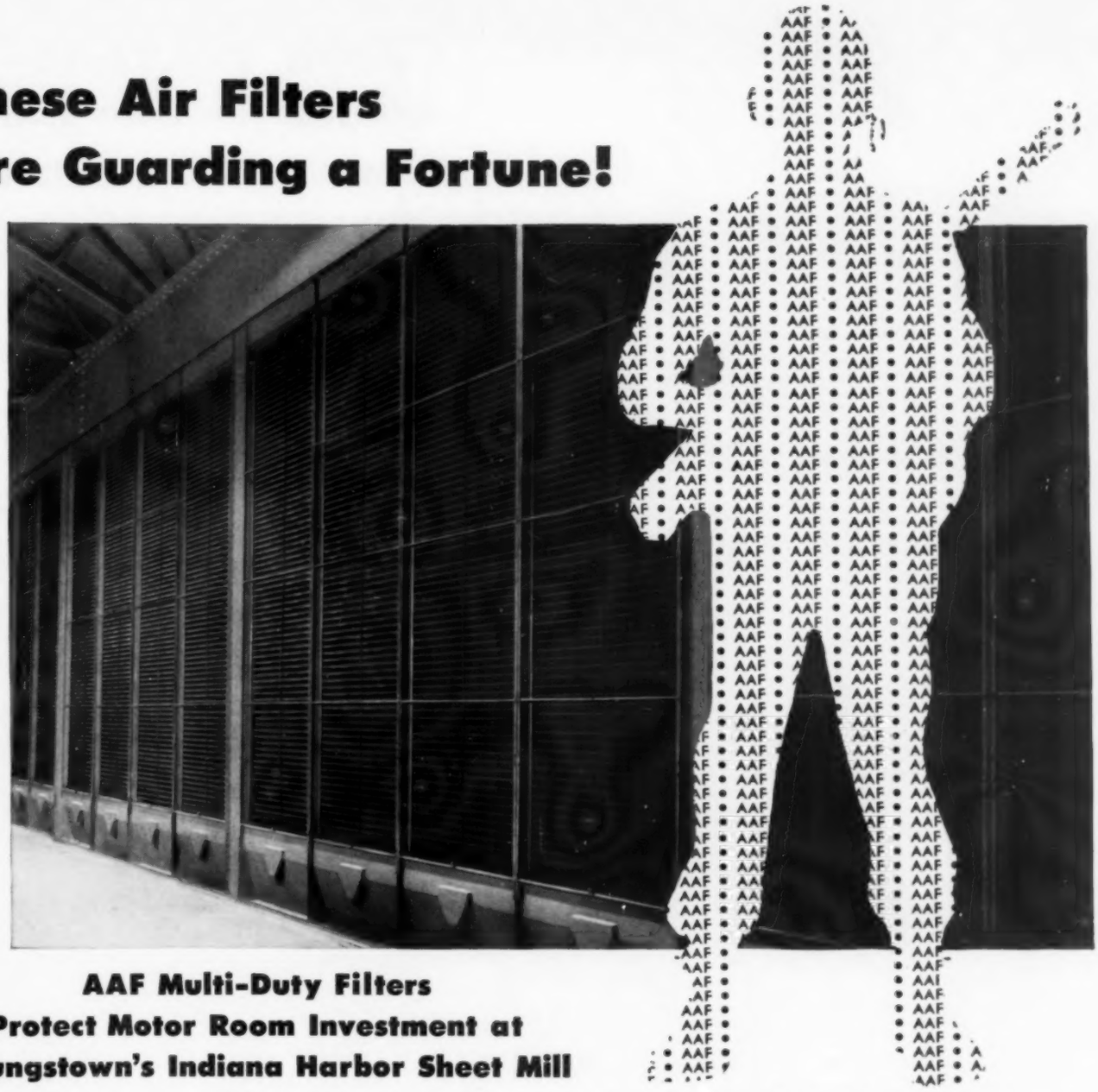

AAF Multi-Duty Filters Protect Motor Room Investment at Youngstown's Indiana Harbor Sheet Mill

THE motor room serving the cold reduction mill at Youngstown Sheet and Tube Company houses a fortune in motors, generators and switch gear. Constant ventilation of this room is essential to prevent equipment from overheating—and the air must be clean. Dust and dirt provide a path for costly electrical losses; play havoc with coils and windings.

Pictured above is the "wall" of AAF Multi-Duty automatic air filters, totaling 533,000 cfm capacity, which supplies this vital protection. With these self-cleaning units standing guard, constant efficiency and uniform air cleaning are assured regardless of dust load. Multi-Dutys never punch a time clock. They're on the job every minute of the day; require no attention other than periodic inspection and removal of sludge.

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ABOVE — Type 700-B, high voltage combination starter of Cubicle construction. RIGHT — Group mounting of high voltage Cubicles shown in actual use.

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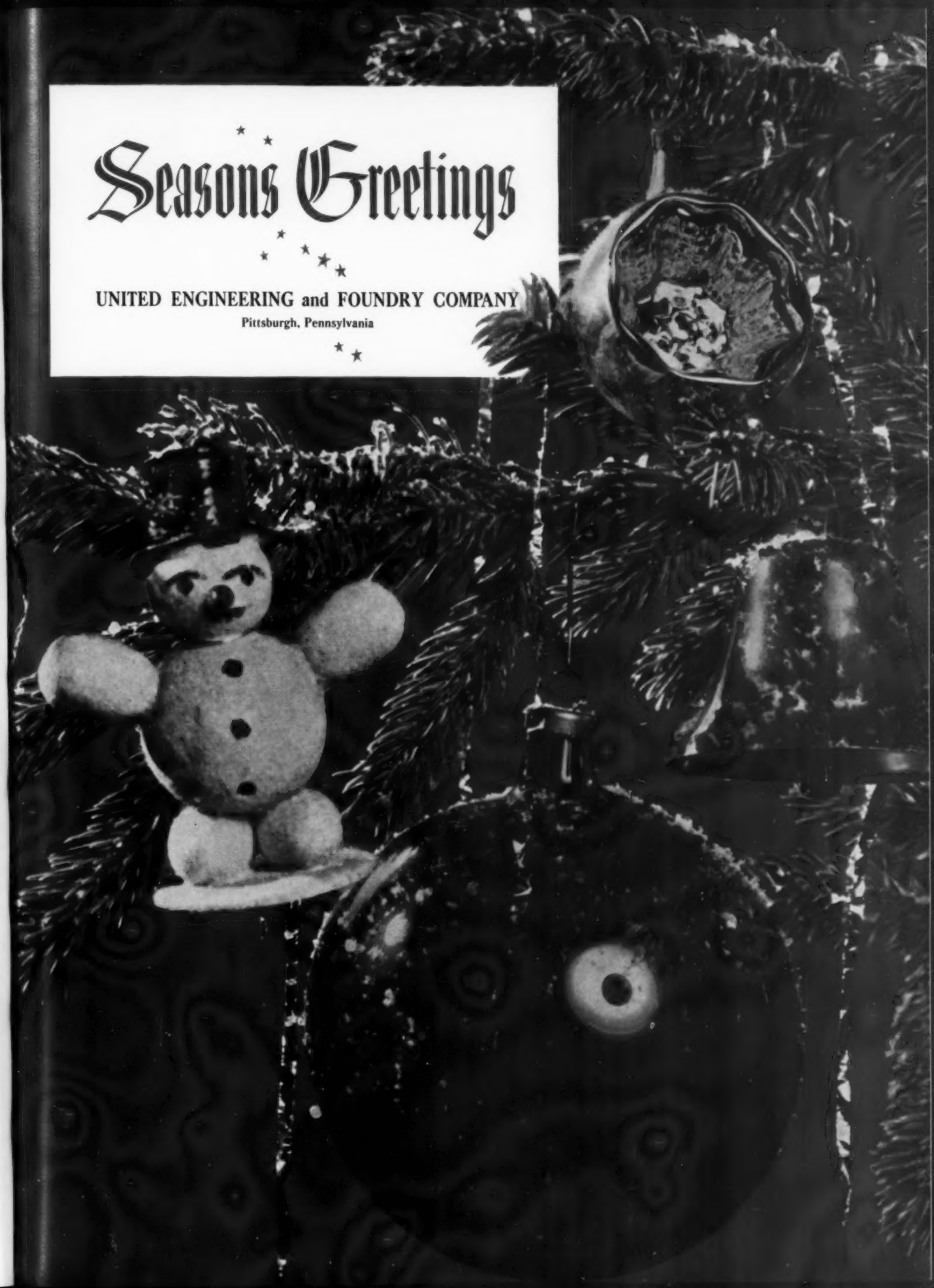
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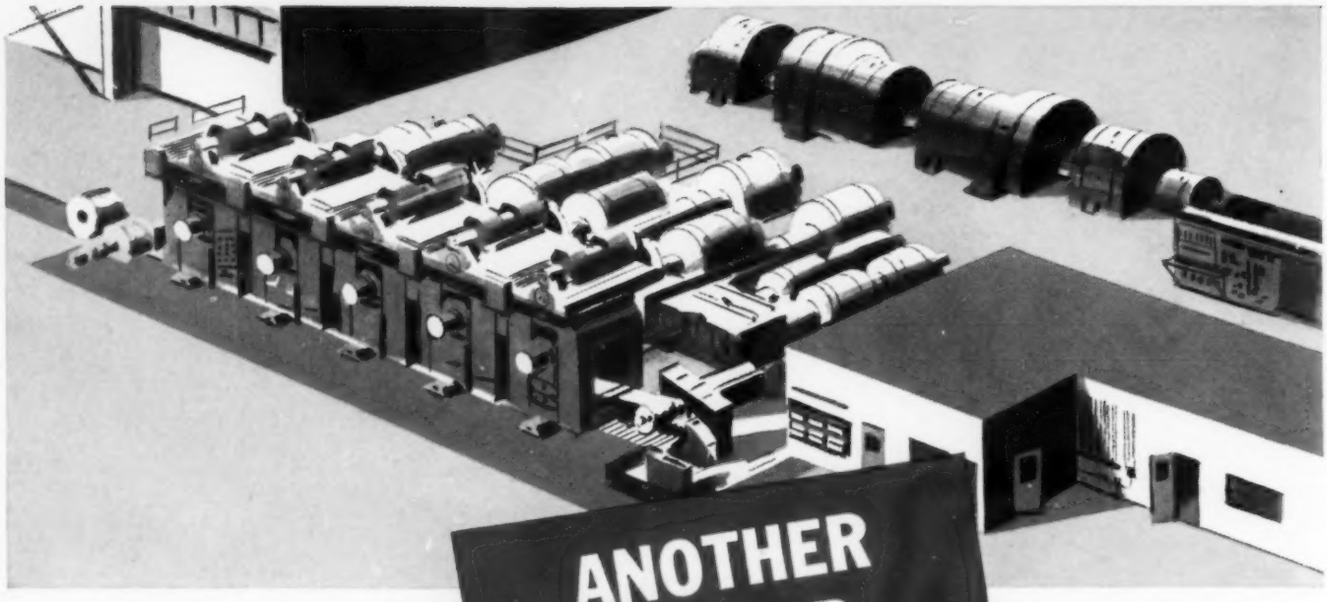

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By MELVIN NORD, Patent Attorney, Detroit, Mich.

Patent Reviews

. . . . copies of patents may be obtained from the Commissioner of Patents, Washington 25, D. C., at 25 cents each . . . . patents reviewed cover period August 10, 1954 to August 31, 1954 . . . .

METHOD OF MAKING A WROUGHT IRON PRODUCT

▲ U. S. 2,686,742, issued Aug. 17, 1954 to Edward B. Story, and assigned to A. M. Byers Co., relates to a method of making a wrought iron product involving fragmenting elongated slag fibers of wrought iron by working the wrought iron at a temperature below the temperature at which the slag fibers lose their plasticity, and coalescing the fragmented slag fibers.

In the manufacture of wrought iron the practice has been to hot roll the wrought iron to elongate the slag inclusions, so as to produce relatively fine elongated slag fibers. The wrought iron thus produced has been characterized by high longitudinal ductility and low transverse ductility. On the other hand, the result of fragmenting and coalescing slag fibers is to produce in the wrought iron a transverse ductility three times the best transverse ductility previously thought possible.

The wrought iron is rolled parallel to an axis in the wrought iron at a temperature below 1900 F in order to fragment the slag fibers. The fragmented slag fibers are then coalesced by annealing the wrought iron at a temperature above 1900 F. Less working is required if the working temperature is low; for example, at 1600 F, the thickness of the wrought iron should be reduced at least 50 per cent, but at room temperature a reduction of 10 per cent is sufficient.

The result of this treatment is shown by the before-and-after photographs. Figure 1 is a photomicrograph of conventional wrought iron. Figure 2 shows the treated type wrought iron at one hundred magnifications, and Figure 3 at one thousand magnifications.

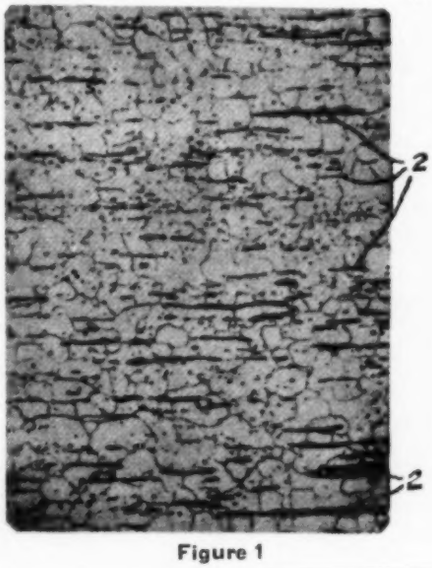

Figure 1

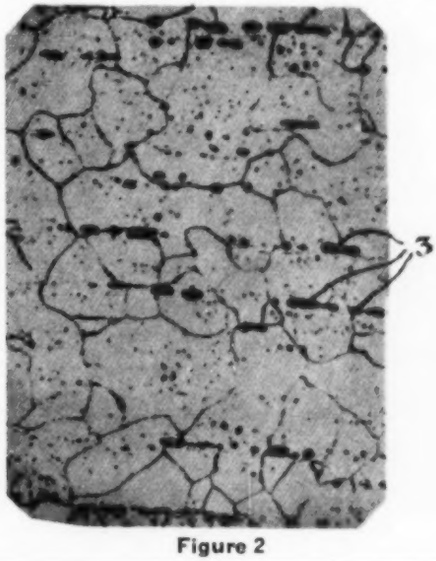

Figure 2

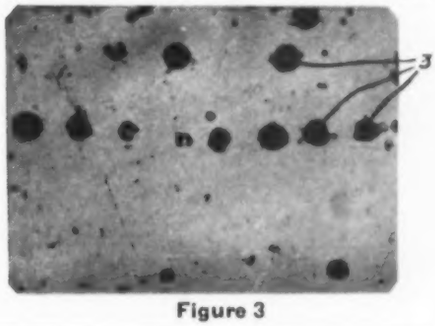

Figure 3

CROSS-ROLLING MILL

U. S. 2,686,441, issued Aug. 17, 1954 to Stephen W. Girgosh and assigned to The National Supply Co., relates to cross-rolling mills of the type that are used for piercing solid blanks or billets which are then used in the manufacture of seamless tubes.

Cross-rolling mills of this type are usually provided with upper and lower shoes confining work pieces while they are being cross rolled. Customarily the lower shoe is so positioned in a roll pass that the axis of the billet lies slightly below the center line of the roll pass, which results in the work piece being forced downwardly against the lower shoe by the roll reaction. Because of this, the lower shoe is subject to greater wear than the upper shoe, and it may become red hot by frictional heat.

In the operation of cross-rolling mills, the rolls are cooled by streams of water that are continuously applied to their working faces. Some of this water is effective for cooling the upper shoe, but little, if any, of it is effective for cooling the lower shoe, because the sides of the shoes conform quite closely with the contour of the rolls, and hence the upper shoe prevents water that is applied to the rolls from flowing downwardly on the lower shoe.

In the present patent, the upper shoe is notched at its vertical side so that cooling water applied to the rolls can flow down onto the lower shoe for cooling it during the intervals between the cross rolling operations. This is shown in Figure 4, in which one of the cross rolls 1 is shown, along with a pair of upper and lower

shoes 3 and 4 respectively. The side of the upper shoe 3 is provided with a vertical notch 9 at the throat of the pass, thereby forming a passage for the flow of cooling water. In the interval between each piercing operation, the rotation of roll 1 towards the pass facilitates the flow of water through the passage to the lower shoe 4 for cooling it.

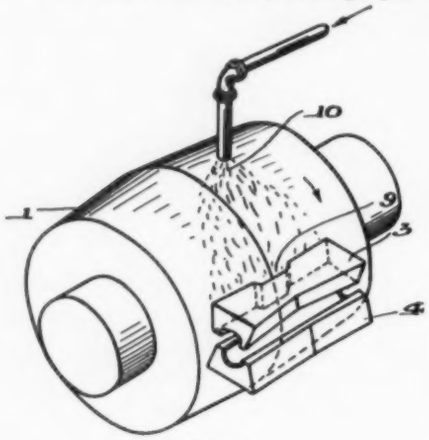

Figure 4

The inventor claims that this simple expedient increases the life of the shoe by a factor of four, from 250 pierced blanks normally to a thousand by this method.

TUBE MILL GUIDE

U. S. 2,686,444, issued Aug. 17, 1954 to Reymond M. Reichl and assigned to Hydropress, Inc., relates to an outlet guide for a seamless tube mill, and particularly to an arrangement guiding the rotating piercer rod before the pierced pipe emerges from the mill, and for holding the pipe with the piercer rod in it as the pipe emerges from the piercer mill.

Figure 6

A number of guide stands are provided, having guide rolls which are automatically adjustable so that they can closely engage the piercer rod, or open up and closely engage the exterior of the tube or pipe being formed. Arrangements also are provided to open the roll members to a position which is of greater diameter than the tube so as to permit the tube to be removed with ease.

FOUR-HIGH ROLLING MILL

U. S. 2,685,807, issued Aug. 10, 1954 to Edwin B. Hudson and assigned to Armco Steel Corp., has for its object to provide a four-high rolling mill capable of rolling very thin gage metal in wide widths with very substantial reductions per pass, for example 0.005-0.010 in. gage in widths 5000 to 10,000 times the gage. This is accomplished by using small diameter work rolls, supported and driven in a novel way.

APPARATUS FOR TENSIONING STRIP

U. S. 2,686,639, issued Aug. 17, 1954 to Clarence H. Campbell and assigned to United States Steel Corp. relates to apparatus for tensioning razor blade stock prior to its entry into a tempering line.

The method of strip hardening is shown diagrammatically in Figure 5, in which the numeral 2 indicates a reel for supporting the coil of strip S to be hardened. From the reel 2 the strip passes through a degreaser 4 and under idler roll 6 to a hardening furnace 8. The tensioning device 10 of the invention is located between the roll 6 and the furnace 8. From the hardening furnace the strip passes through the cooling block 12, draw furnace 14, cooling block 15 and drawout mechanism 16 to the takeup block 18.

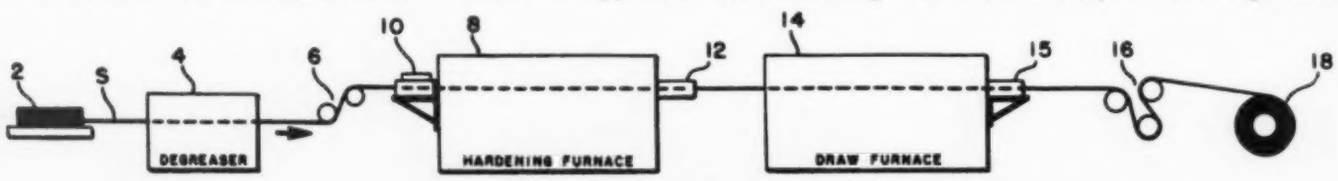

Figure 5

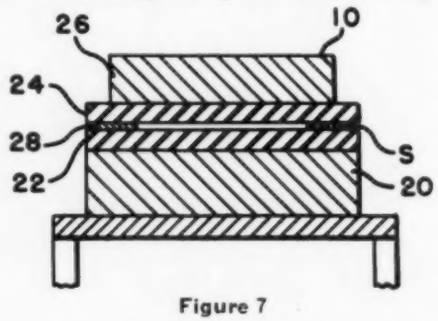

Figure 7

As shown in Figures 6 and 7, the tensioning device includes a supporting block 20 which loosely carries a tungsten carbide wear plate 22. A similar tungsten carbide wear plate 24 is mounted above the plate 22 and a removable weight 26 is mounted on top of the tungsten carbide block 24. A retainer plate 27, having an opening for the strip S, is fastened to the exit end of the block 20 to prevent longitudinal movement of the wear plates. When threading the strip S through the processing line, the block 24 and weight 26 are removed and a shim 28 of approximately the same thickness as the strip S is mounted on top of the tungsten carbide plate 22 adjacent the longitudinal edge of the wear plate. The strip S is passed over the wear plate 22 along the opposite longitudinal edge. The wear plate 24 and weight 26 are then placed on top of the shim 28 and strip S. By use of this arrangement the back tension applied to the strip S will be relatively uniform regardless of variations in the thickness of the strip which often occurs. The amount of tension can be varied by changing the size of weight 26. As the strip S passes between the wear plates 22 and 24, any burrs that might be on the strip will be at least partially removed.

COOLING THE HEARTH OF A BLAST FURNACE

The hearth walls of blast furnaces are normally constructed of a thickness upwards of 30 in. Furnaces taken out of service even long before the termination of a general lining campaign are frequently found to have a remaining hearth wall thickness of approximately 10 in., indicating that the hearth wall disintegrated early in its career to a most undesirable extent. So thin a hearth wall introduces an element of danger because of the fact that a stoppage or failure of the water flow through a

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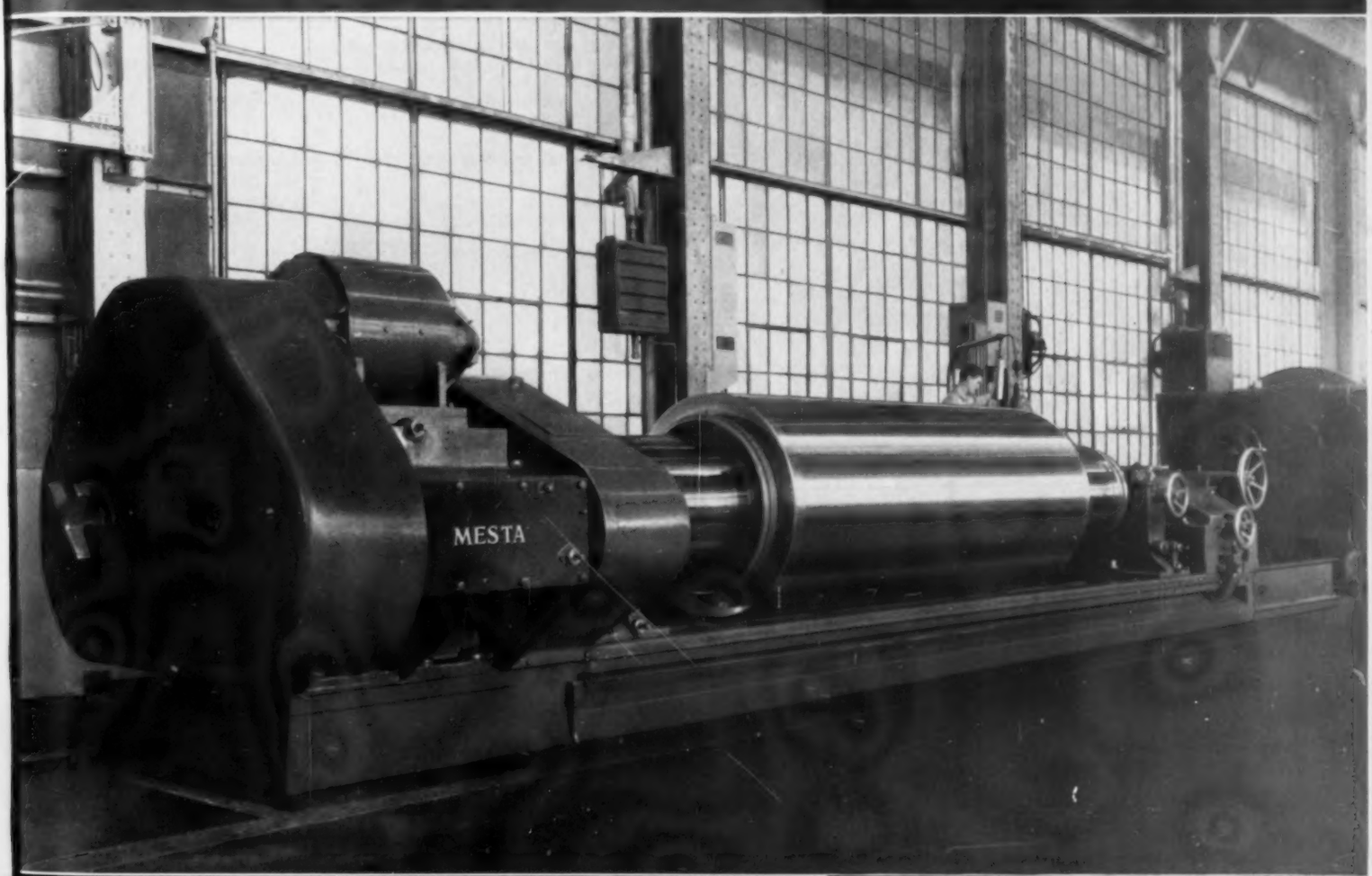

Mesta Heavy Duty Traveling Wheel Type Roll Grinder
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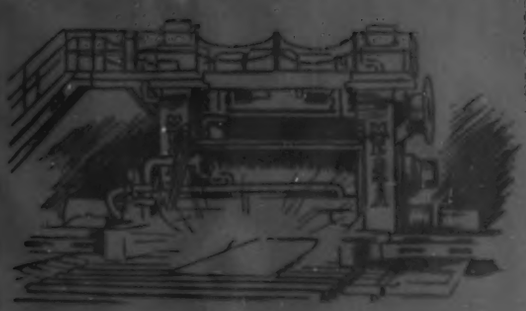

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cooling element or even through one component might readily lead to local overheating and further thinning of the already thin wall so as to present the imminent hazard of a break-through of molten iron and slag.

U. S. 2,686,666, issued Aug. 17, 1954 to Bruce E. Tau and assigned to Koppers Co., Inc. provides means of cooling the hearth so as to prevent undue thinning of it.

In Figures 8, 9, 10, and 11, the hearth is indicated by the numeral 10, which hearth is provided with the

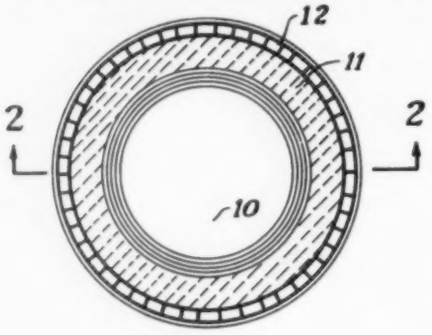

Figure 8

cylindrical wall 11 providing a receptacle for molten metal. Surrounding the hearth 10 and the lower portion of the wall 11 are a number of metallic cooling staves 12. Embedded in the staves are pipes 13 connected together to provide a circuitous route for cooling water.

The outer course of bricks of the hearth 16 and wall 11 are indicated

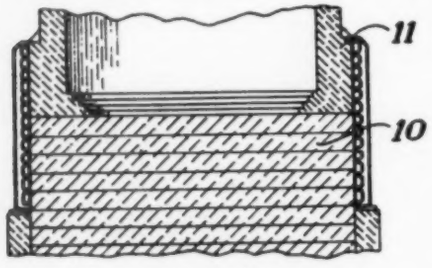

Figure 9

by the numerals 14. The bricks 14 are of such shape and are disposed in such a manner as to secure when cast into the metal of the staves 12, metallic intrusions 15 extending between adjacent bricks 14, whereby intimate contact is provided between the cooling staves 12 and the bricks 14.

Since the metallic intrusions surround the cast-in bricks on four sides, and since the body of the cooling staves contacts the cast-in bricks on their fifth sides, the area of brick-to-metal contact is at least five times the area of contact secured in previous constructions in which the bricks adjacent to the staves are laid edgewise or endwise, with only one of the smaller area faces in contact with the staves. By reason of this five-fold extension of contact area alone, the thermal conductancy between the hearth wall 11 and the cooling staves 12 is increased five-fold.

Bricks 16 are the innermost bricks of the hearth wall, and are bonded to

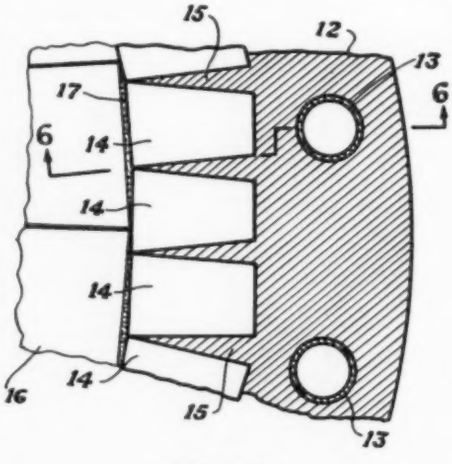

Figure 10

the cast-in bricks 14 with fire-clay grout 17 just as they are bonded to one another and to the other bricks of the hearth wall, the grout joint having a thermal conductivity slightly less than that of the brick itself.

Because of the greatly improved intimacy of contact and because of the increase in contact area between the cast-in bricks and the metal of the cooling staves, the objectionable heat gradient between the outer course of the outer wall and the cooling element is greatly reduced.

As the result of the improved degree of thermal conductancy between hearth wall 11 and cooling staves 12 arising only from the five-fold increase in area of contact surface, the increased heat flow from wall to cooling staves is such as to hold the inside surface temperature of the wall to or below the critical temperature of between 2350 and 2400 F, while maintaining a wall thickness of approximately 20 in. as compared with about 10 in. of wall thickness as commonly is the case.

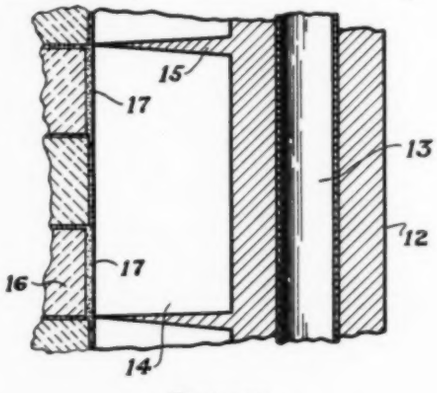

Figure 11

With the additional benefits to thermal conductancy residing in the factor of greater intimacy of contact between brick and metal, the preservation of more than 20 in. of wall thickness is indicated.

OTHER PATENTS OF INTEREST TO THE IRON AND STEEL ENGINEER

Patent No.	Date	Subject	Inventor or Assignee
2,686,115	8/10/54	Low-alloy steel containing boron for high-temperature use	The Timken Roller Bearing Co.
2,686,116	8/10/54	Age hardening austenitic steel	Crucible Steel Co. of America
2,686,443	8/17/54	Manipulator for rolling mills	The Loewy Engineering Co., Ltd.
2,686,488	8/17/54	Method of treating and cold deep drawing sheet metal	Harley A. Montgomery
2,686,664	8/17/54	Annealing cover	Whitehead & Kales Co.
2,686,665	8/17/54	Heat-treating furnace	Leeds and Northrup Co.
2,686,743	8/17/54	Heat-treated ferrous alloy castings	American Brake Shoe Co.
2,687,052	8/24/54	Apparatus for controlling the rolling of tapered sheets	Hydropress, Inc.
2,687,294	8/24/54	Pressurized cupolas	Herbert A. Reece
2,687,349	8/24/54	Production of iron powder from iron carbonyl	Badische Aniline- & Soda-Fabrik A.G.
2,687,854	8/31/54	Self-centering uncoiler	United States Steel Corp.
2,687,929	8/31/54	Anchorage for thrust bearing hoods of rolling mill rolls	John H. Griffith & Rudolph A. Minarik
2,687,954 & 2,687,956	8/31/54	Nickel-chromium-iron alloy	Driver-Harris Co.
2,687,955	8/31/54	Cold-workable stainless steel	Armco Steel Corp.

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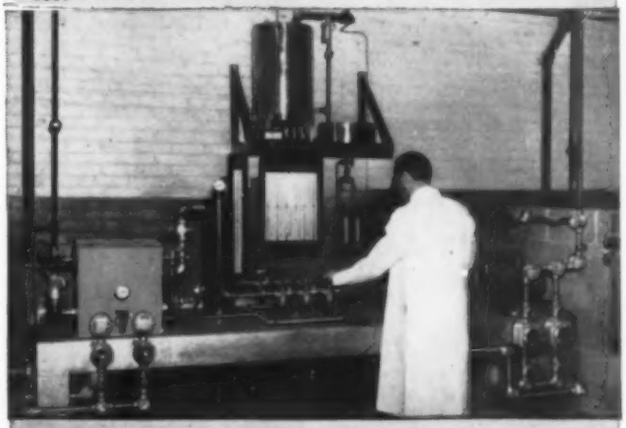

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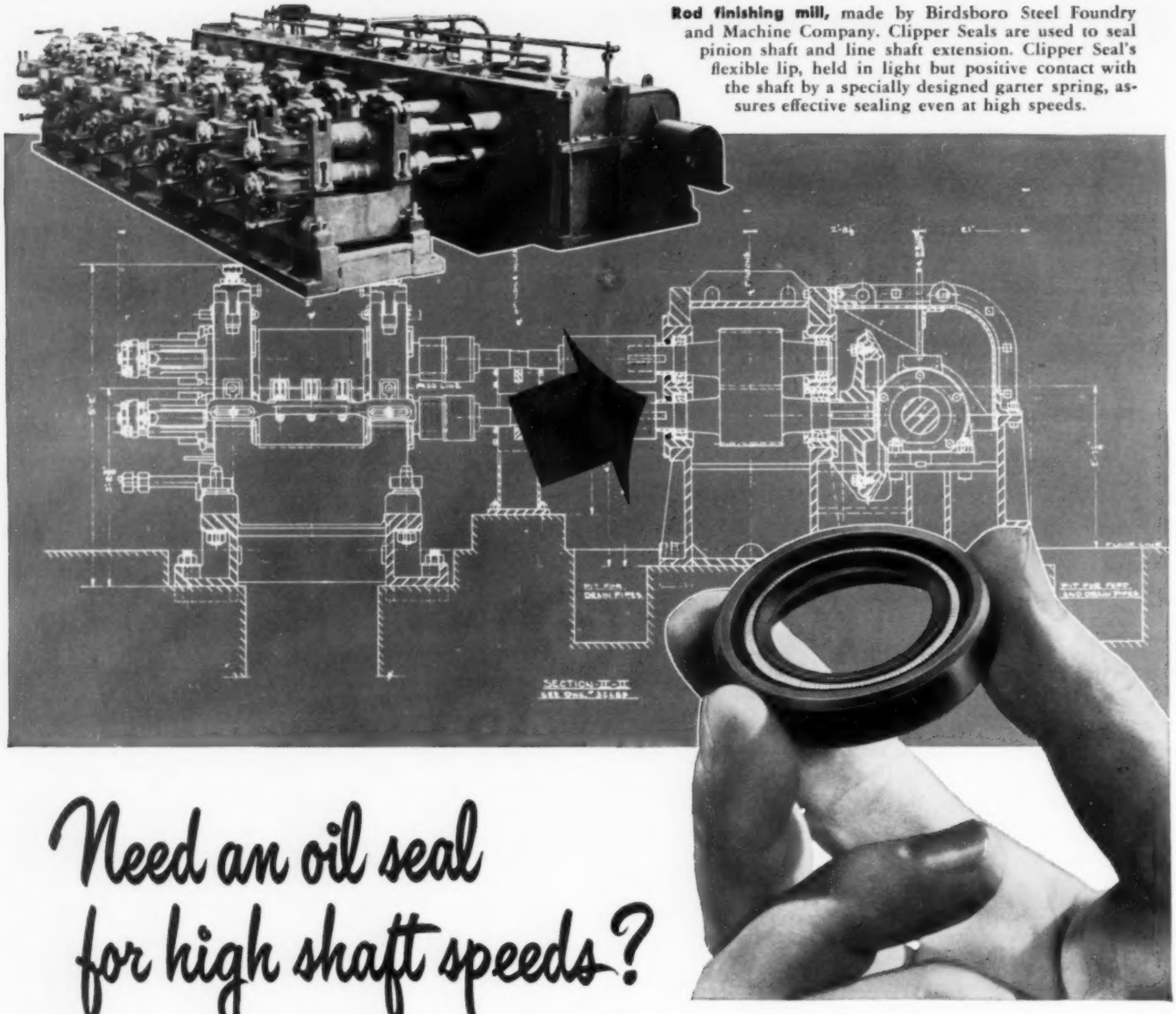


Rod finishing mill, made by Birdsboro Steel Foundry and Machine Company. Clipper Seals are used to seal pinion shaft and line shaft extension. Clipper Seal's flexible lip, held in light but positive contact with the shaft by a specially designed garter spring, assures effective sealing even at high speeds.

Need an oil seal for high shaft speeds?

Birdsboro chose Clipper Seals

The Birdsboro 8-stand finishing train shown above is expected to operate around the clock, day in and day out. And since it is to be part of a large, high-speed, steel rod producing unit, Birdsboro designed it to be as maintenance-free as possible.

In order to minimize down time, particular attention was paid to bearing design and lubrication. The mill stands are equipped with open, water-lubricated bearings. Because of high shaft speeds, bearings in the combination spiral bevel gear reduction and pinion stand are anti-friction in type, lubricated with circulating oil, and sealed with Clipper Seals.

Birdsboro engineers chose Clipper Seals for this application because of their outstanding ability to withstand the heat of friction generated by high shaft speeds . . . and their ability to make a tight and lasting seal against the circulating bearing lubricant.

Still other reasons for Birdsboro's preference for Clipper Seals: They are precision-molded, compact in design, and exceptionally easy to install. They may be removed and replaced without impairing their sealing efficiency. And because of their unique design, Clipper Seals cause a minimum of shaft wear.

Precision-molded Clipper Seals are made in a variety of designs to meet almost any sealing condition. They are available in split and endless types, with a choice of heel and lip combinations for various services. For details, write for Brochure PK-46A. Address, Johns-Manville, Box 60, New York 16, N. Y. In Canada, 199 Bay Street, Toronto 1, Ontario.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville CLIPPER SEALS

JUMBO COILS

from a BLISS WELD-A-MATIC SPLICER

mean . . . longer mill runs . . . less handling time

High-speed end to end welding of ferrous and non-ferrous strip on this Weld-A-Matic Splicer builds up coils to larger sizes, greater weights. And automatic, rapid coil build-up means practically continuous mill operation . . . longer mill runs . . . less handling time.

The Splicer butt welds brass or copper strip, low, medium and high carbon strip, chrome and nickel-chrome stainless strip, silicon strip and several grades of aluminum—using the shielded arc principle. The weld itself is clean, ductile, and as strong as the metal itself. No trimming is required on the weld before it enters strip-processing machinery.

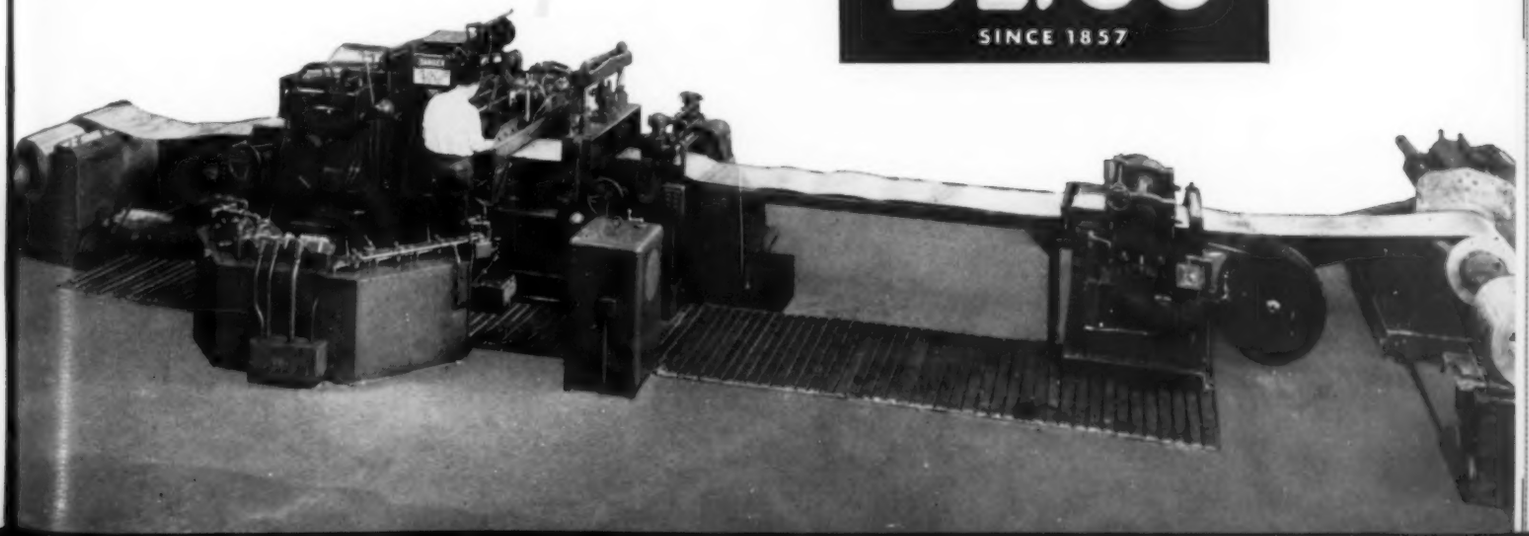
These completely integrated machines combine shears, clamps and welders—all the parts necessary to prepare and weld strip for building up coils to larger sizes . . . to reunite silicon sheets into continuous strands and coils following special processing . . . and to weld strip or skelp end-to-end for continuous feeding into production lines.

Gages spliced range from 0.014″ to 0.3125″; speeds from 25 to 120 inches per minute depending upon the gage. No special welding skills are required by operators.

For more information about Weld-A-Matic Splicers, and what they can mean to you, write or call today.

E. W. BLISS Company
General Office: Canton, Ohio
ROLLING MILL DIVISION: SALEM, OHIO

BLISS
SINCE 1857



Carbon removal with Airco oxygen—a simple process used in the refining of electric furnace steel.

AIRCO OXYGEN

. . . the Steel Industry's most versatile tool

The applications and advantages of oxygen in the steel industry are virtually without limit. The decarburization of electric furnace steel is a worthy example. Pioneered by Airco, the "decarb" process eliminates iron ore as an oxidizing agent in most steel mills. It makes realistic savings possible in power, heat time, refractory cost, and alloys while promoting faster removal of carbon and a more uniform, high-quality metal.

Similarly, other phases of steel production have been improved through the introduction of tools and techniques whose effectiveness depends on oxygen. Scarfing, scrap preparation, and gas hot topping of ingots exemplify the ever-growing use and importance of Airco oxygen and Airco equipment.

Airco's research and development staff will continue to work hand in hand with steel men to contribute new and better methods of steel production. For helpful technical information on applying Airco processes to your particular problem, write to the Airco Technical Sales Division. Address the Air Reduction Office nearest you.

The "granddaddy" of using oxygen for salvaging scrap—still going strong today. Using Airco equipment in lancing and cutting 15-ton buttons.

AIRCO®

AIR REDUCTION

60 East 42nd Street • New York 17, N. Y.

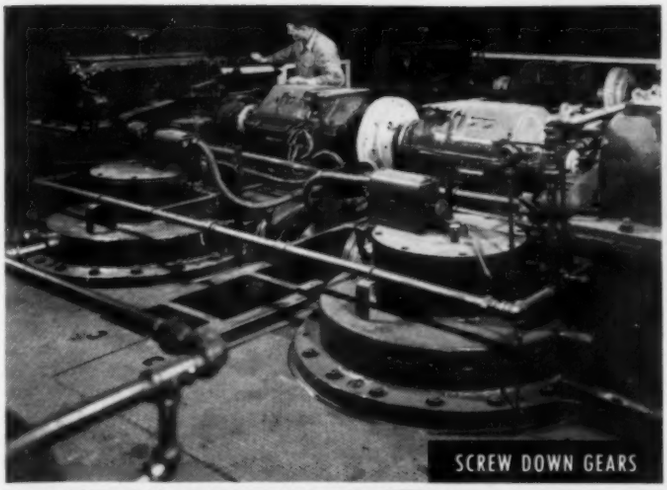
Divisions of Air Reduction Company, Incorporated, with offices in most principal cities

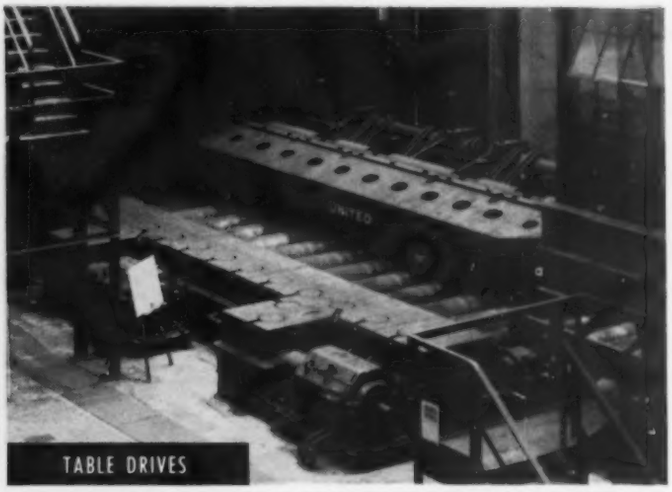
Air Reduction Sales Company
Air Reduction Pacific Company

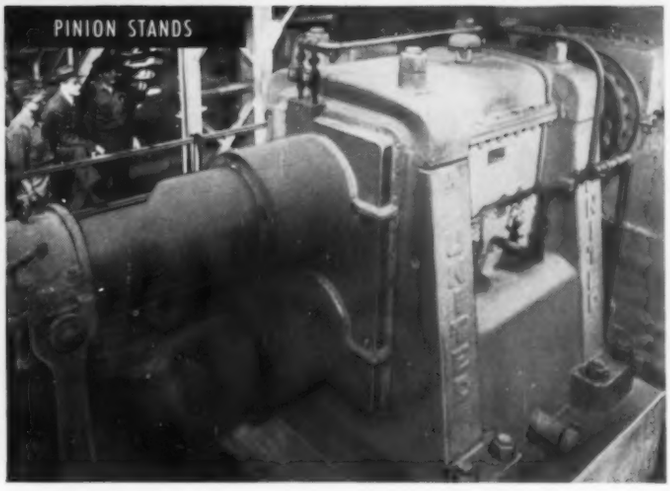
Represented Internationally by
Airco Company International

Foreign Subsidiaries: Air Reduction Canada, Limited, Cuban Air Products Corporation

Products of the divisions of Air Reduction Company, Incorporated, include: AIRCO — industrial gases, welding and cutting equipment, and acetylenic chemicals • PURECO — carbon dioxide, liquid-solid ("DRY-ICE") • OHIO — medical gases and hospital equipment • NATIONAL CARBIDE — pipeline acetylene and calcium carbide • COLTON CHEMICAL COMPANY — polyvinyl acetates, alcohols and other synthetic resin products.







Get protection *plus* for your gear drives with GULF E. P. LUBRICANTS

Get the advantage of the extra load-carrying capacity of Gulf E.P. Lubricants, plus excellent water separating and rust preventive properties, plus exceptional stability for this type of lubricant, plus effective nonfoaming and noncorrosive characteristics.

This "plus protection" of Gulf E.P. Lubricants not only prevents excessive gear wear but insures freedom from rust, foaming, and other lubrication troubles.

The next time you order gear drive lubricants, make it an order for safe, sure protection and lower maintenance costs — specify Gulf E.P. Lubricants.

For more complete information, or for expert help on your gear drive lubrication problems, send the handy coupon.

GULF INDUSTRIAL LUBRICATION

Gulf Oil Corporation · Gulf Refining Company
1822 Gulf Building, Pittsburgh 30, Pa.

Gentlemen:

I would like further information on Gulf E.P. Lubricants:

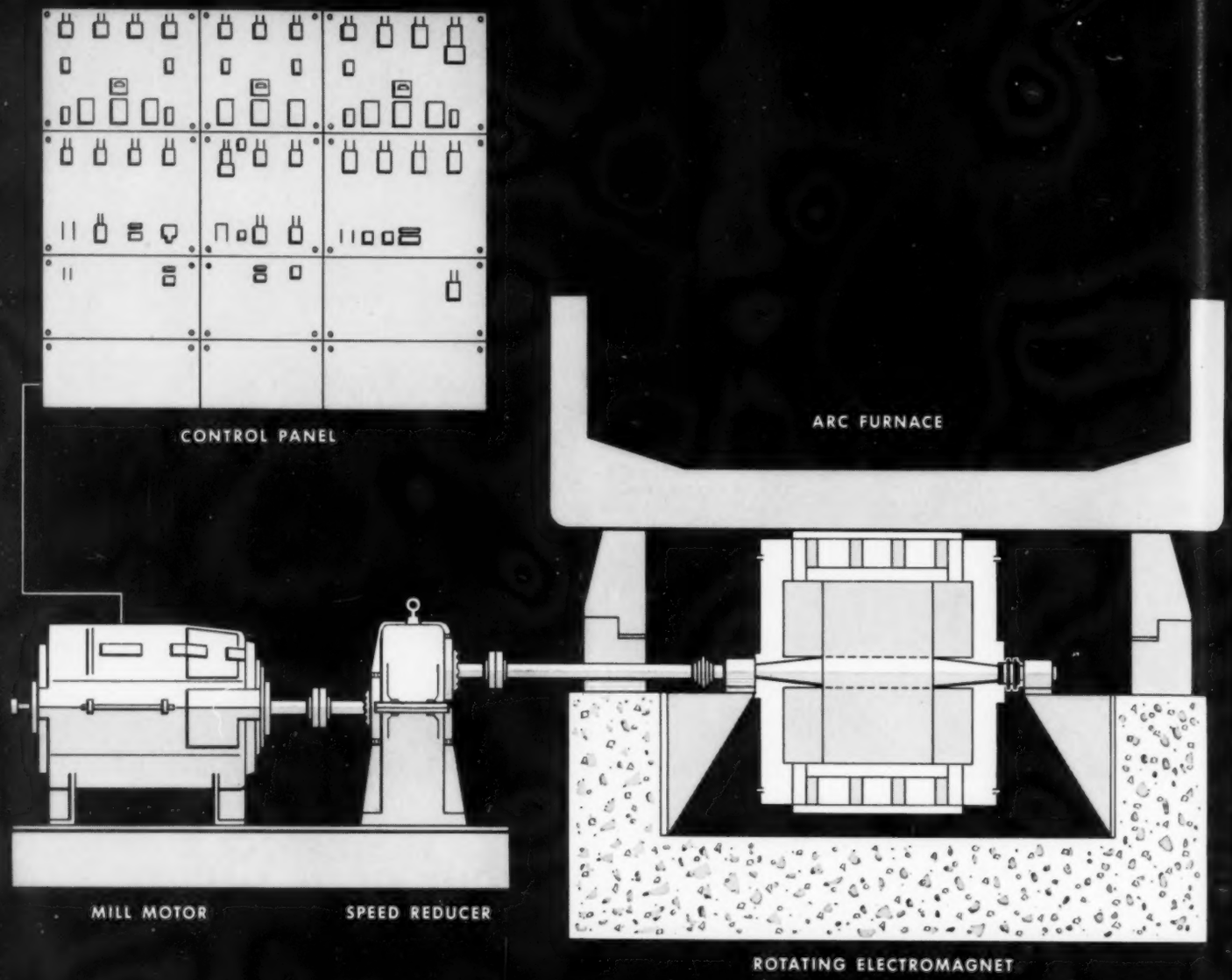
- ☐ Please have a Gulf Sales Engineer call. ISE
- ☐ Please send me a copy of your pamphlet "Gulf E. P. Lubricants for Reduction Gear Drives."
- ☐ Please arrange to show a group in our plant the new Gulf Color Slide Film, "Gears and Their Lubrication."

Name_____

Company_____

Title_____

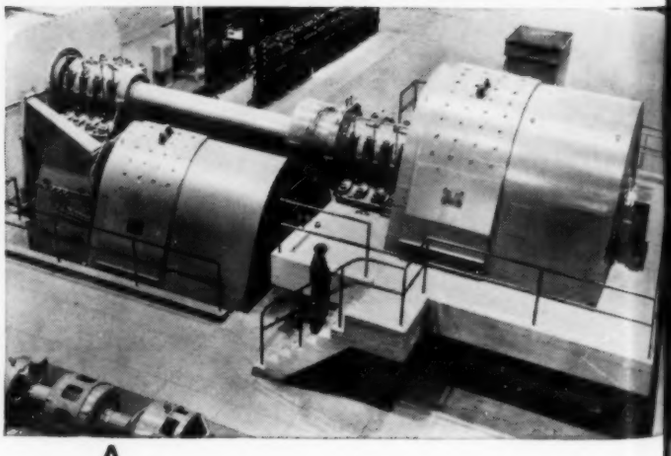
Address_____



Here are two typical steel mill installations that benefit from Thermalastic insulation: (A) a 10,000-hp twin motor drive for reversing blooming mill, (B) a main drive for tandem hot and cold mill. Can Thermalastic be used on your drives? Ask your Westinghouse representative.

(C) Moisture-resistance test on stator winding of a 950-hp, 4160-volt motor. The test lasted 275 hours —200,000 gallons of water poured over the winding.

(D) These results of laboratory spray test show changes in insulation resistance of a Thermalastic-insulated winding compared to Class B winding.



A

New developments by Westinghouse

1. New arc furnace stirrer features standard parts...precise control

Four standard components make up this new Westinghouse rotating-type magnetic stirrer for arc furnaces: a standard 9500 line control panel; a standard Type SHR single-reduction speed reducer; a standard series 600 mill motor; a standard rotating, silicone-insulated, electromagnet. Here is a package that is easy to install, easy to maintain and is engineered to provide consistent performance that is far superior to any similar device on the market today.

Control is precise. Infinite adjustment of exciting current and speed of stirrer rotation are achieved by the new Westinghouse control circuit. Thus the velocity of stirring motion can be accurately controlled to meet your particular requirements. And the range of control is greater. Starting at a bottom limit of zero, stirring velocity can be increased to any practical top speed.

To obtain such advantages as better homogeneity of steel, savings in alloying elements, reduced time of heat, and lowering of sulphur and phosphorous content, call your local Westinghouse steel representative for more information about the new Westinghouse induction stirrer.

2. New Thermalastic* insulation is impervious to dust, dirt and moisture

It is universally conceded that a steel-mill drive motor is exposed to severe operating conditions when the motor is located out in the mill. Dust, dirt, moisture and excessive heat soon take their toll on conventional motor insulating materials. Now, Westinghouse has developed a new, vastly superior insulating material that erases most of these headaches.

Thermalastic is a new mica insulation that has characteristics far superior to any ordinary insulation. An impregnating resin is used that is very stable chemically and has high moisture resistance. This, coupled with a high degree of fill achieved in the impregnating process, renders Thermalastic impervious to contamination from foreign elements found in the mill.

Thermalastic also has: 20% greater dielectric strength, 10 times greater voltage endurance, 30 times greater tensile strength.

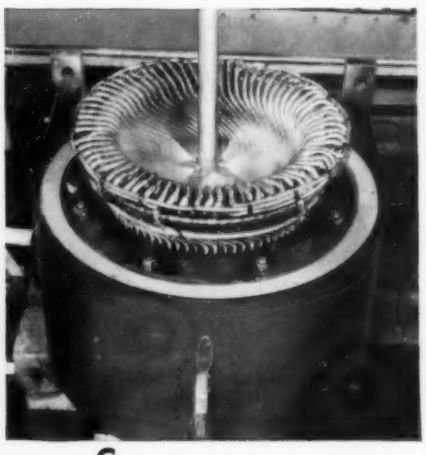
Shown below is a typical laboratory spray test that indicates the resistance to moisture of Thermalastic insulation.

*Trade Mark J-10437

YOU CAN BE SURE...IF IT'S

Westinghouse

B



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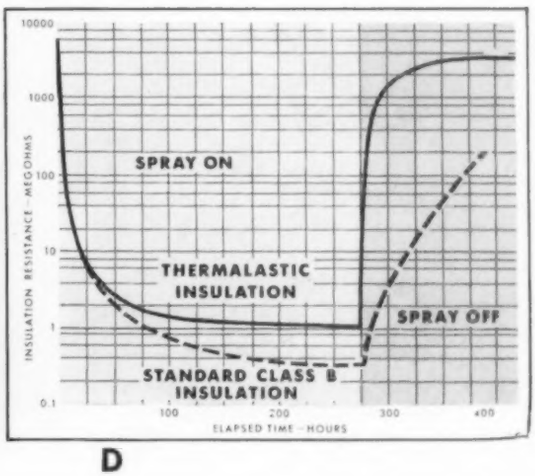


D

HERE'S THE USG BRUSH

THAT DOES AN OUTSTANDING JOB ON AC CRANE MOTOR RINGS

When you replace the brushes on your AC Crane Motor Rings you can get the best results with U S G Grade 550 Brush. For brushes that give superb results in other applications, see below. Write for your copy of the complete U S G Brush catalog today.

A typical U S G Grade 550 Brush for AC Crane Motor Rings

194

U S G Grade 135 Mill Motor Brush with Statite*

U S G Grade 223 Brush for DC crane motors with Statite*

U S G Grade 1658 Brush for tin line collector rolls

U S G Grade AH897 Brush for welding generators with Statite*

*Permanent shunt connection, needing no hammerclips; cannot be jarred loose or pulled out.

OUR 100th YEAR

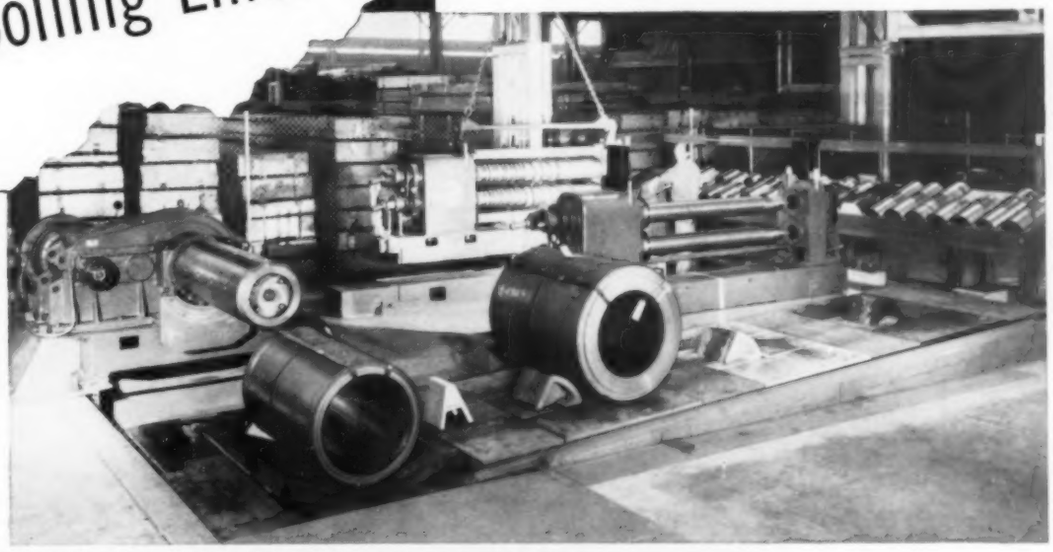
THE UNITED STATES GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION • SAGINAW, MICHIGAN

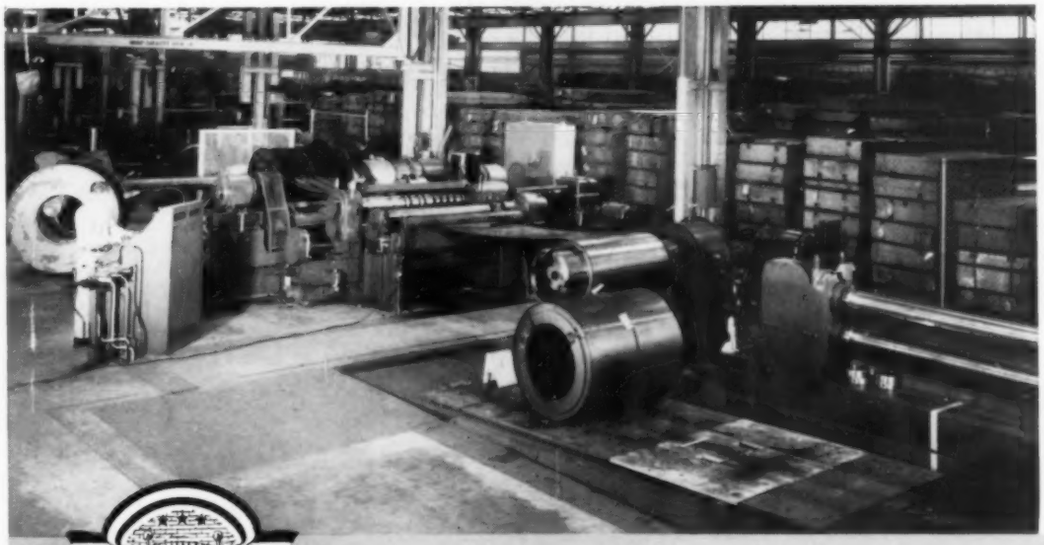
Step Up Production with Stamco Slitting and Coiling Lines

Stamco Slitting and Coiling Lines will step up your production because they are designed to meet your particular specifications. Years of experience have led to the development of equipment that will meet every slitting and coiling requirement. Stamco slitting and coiling lines are now efficiently handling coils from 500 to 60,000 pounds and are designed to give dependable, maintenance-free service.

Write us, stating your requirements . . . we'll gladly give complete details — no obligation.



View shows coil lift and traverse, coil pay off reel, coil loading ramp and detachable slitter head.

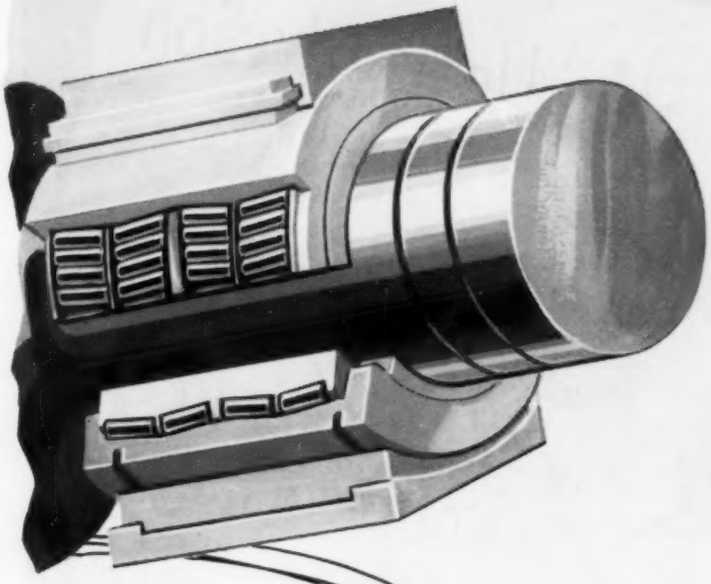


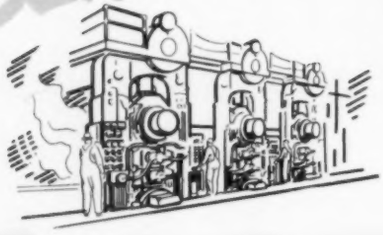
Overall view of coiling line from entrance end.

LAY YOUR SHEARING PROBLEMS AT STAMCO'S DOOR

STAMCO, Inc., New Bremen, Ohio

FOR SEVEREST ROLLER BEARING SERVICE





BROOKS * LEADOLENE 375

*THE I.P. LUBRICANT WITH ***Indestructible pH-ilm***

Brooks Leadolene 375 provides safe, trouble-free lubrication of roller bearings under heaviest loads, overloads and severest shock conditions, such as experienced in heavy duty work roll service on 4 high hot strip mills, reduction mills and temper pass mills. Developed through years of research, this modern industrial lubricant provides corrosion resistance to component parts of bearing from cooling water and other contaminating actions.

Available in three grades . . .

Leadolene 375 Light: For normal or moderately high temperatures, with repellence of water a dominant factor. Excellent pumpability.

Leadolene 375 Medium: For heavier load and higher temperature requirements. Prevents leakage through seals. Excellent pumpability. Affords year around service under all temperature conditions.

Leadolene 375 Heavy: For pressure gun or system applications in normal or high temperatures. Good pumpability.

A Brooks lubrication engineer will gladly call at your request. Write, phone or wire today.

THE BROOKS OIL COMPANY
934 Ridge Avenue
Pittsburgh 12, Pa.

Please send bulletin on Leadolene 375.

NAME_____

TITLE_____

COMPANY_____

ADDRESS_____

CITY_____ ZONE____ STATE_____

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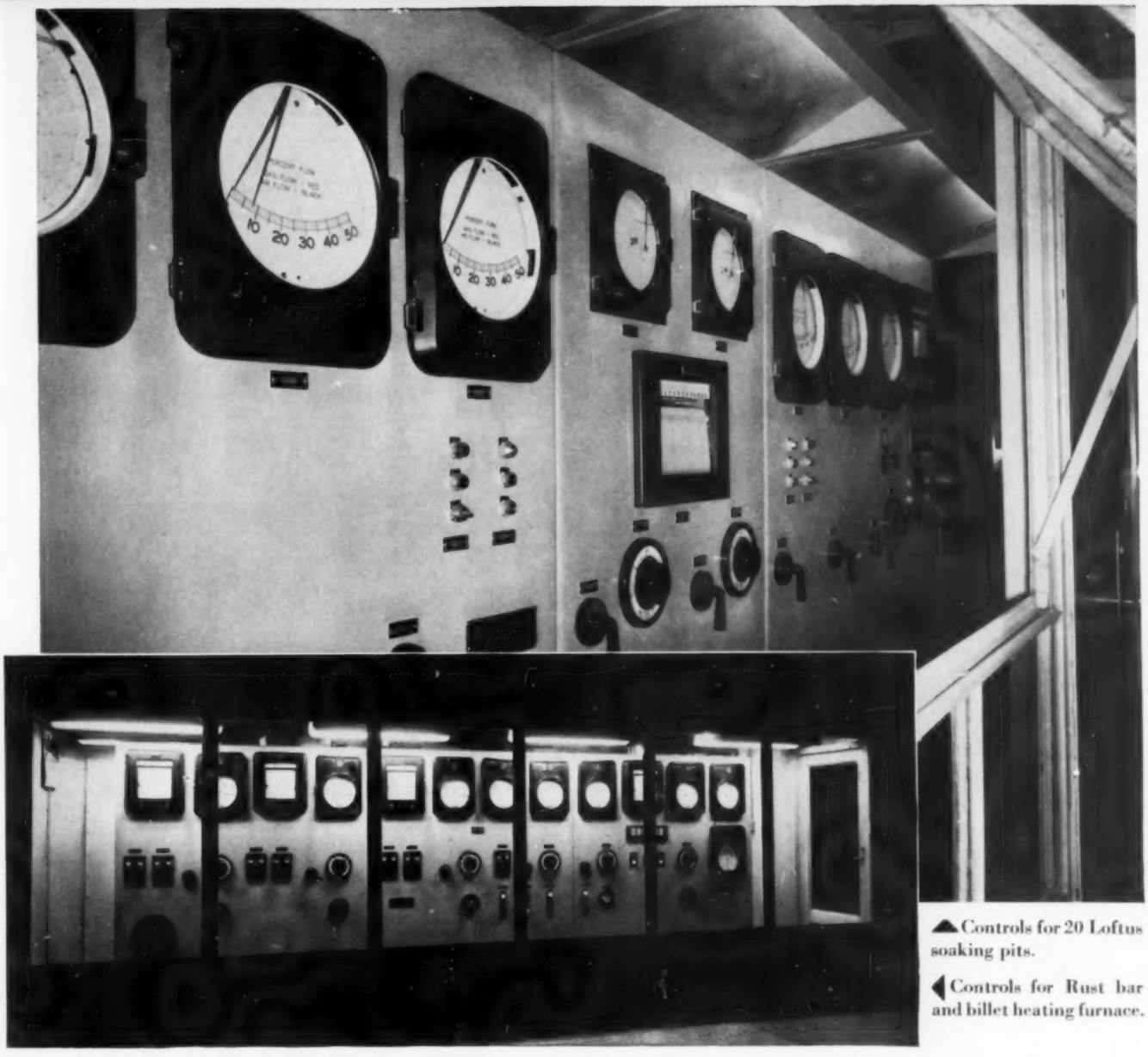
The Brooks Oil Company

Since 1876

Executive Offices and Plant, Cleveland, Ohio
Executive Sales Offices, Pittsburgh, Pa.
Canadian Offices and Plant, Hamilton, Ontario
Cuban Office, Santiago de Cuba
Warehouses in Principal Industrial Cities



▲ Controls for 20 Loftus soaking pits.

◀ Controls for Rust bar and billet heating furnace.

ASKANIA supplies four combustion control installations at the Fairless Works, United States Steel Corporation

Steel men at the Fairless Works of the United States Steel Corporation, Fairless Hills, Pa., selected the control installations above to control a Rust bar and billet heating furnace and a battery of 20 Loftus soaking pits. Not illustrated are other controls for Wilputte coke ovens and Ingersol-Rand blast furnace blowers.

When steel men need combustion controls they choose Askania—just as they have been doing for twenty years. They know that Askania controls are common-sense controls—simple and sturdy—designed and built to do the hardest jobs for the longest time. They know that Askania controls make their job easier and their results better. They know they can get fine controls for their combustion needs—pressure, flow, fuel and air proportioning, and furnace reversal controls—tools that make more steel and better steel for less money.

Askania will solve your combustion control problems—Write for Bulletin 139

ASKANIA REGULATOR COMPANY

246 E. Ontario Street, Chicago 11, Illinois

A SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORPORATION

How deep-ribbed cases protect

DEEP-DOWN
PULLING POWER

The cooler the magnet, the better its lifting efficiency. That's why powerful, deep-field Stearns lifting magnets are designed for maximum heat dissipation. In both the welded and bolted units, the heavily ribbed magnet case provides greater radiation area, for cooler and more efficient operation.

This design also provides greater protection against internal and external damage in the event of rough handling. These are important reasons why you can operate Stearns magnets profitably on steady, long-shift duty.

In addition to fast heat dissipation, Stearns magnets offer the following advantages:

- **Permanently sealed magnet coil not disturbed when servicing terminals or pole shoes.**
- **Leads and terminals fully protected against abrasion and shock.**
- **Vacuum-impregnated windings assure long life, and dependable operation.**
- **Waterproof construction.**

Stearns lifting magnets — both circular and rectangular are available in a wide range of standard sizes. Custom-built models on request. See your Stearns representative or write for Bulletin 35-B-2.

1092

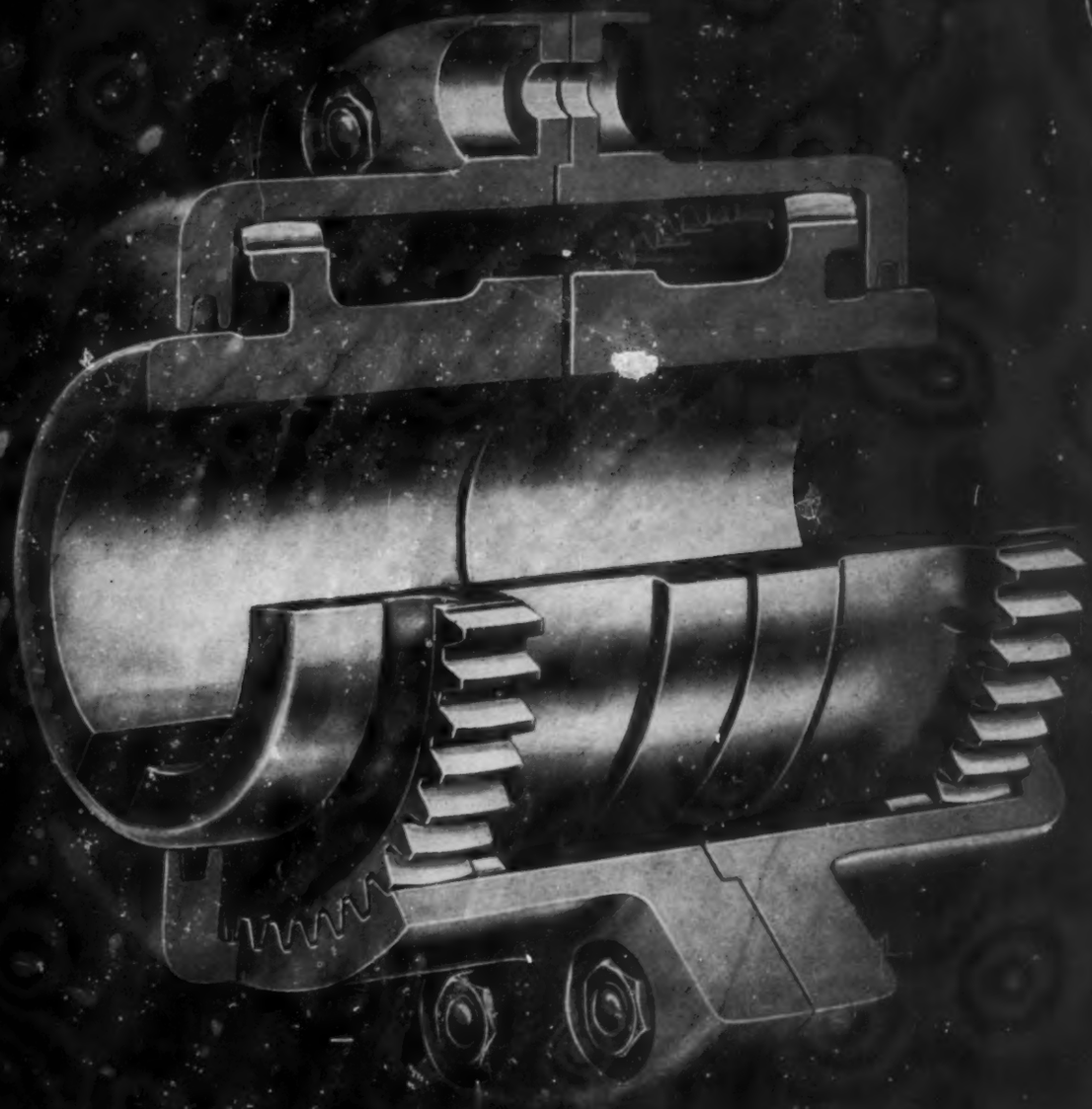
Stearns circular lifting magnet carrying a 4,000-lb tank track.

MAGNETIC EQUIPMENT FOR ALL INDUSTRY

STEARNS MAGNETS

STEARNS MAGNETIC, INC. 681 S. 28th St., Milwaukee 46, Wis.

POOLE

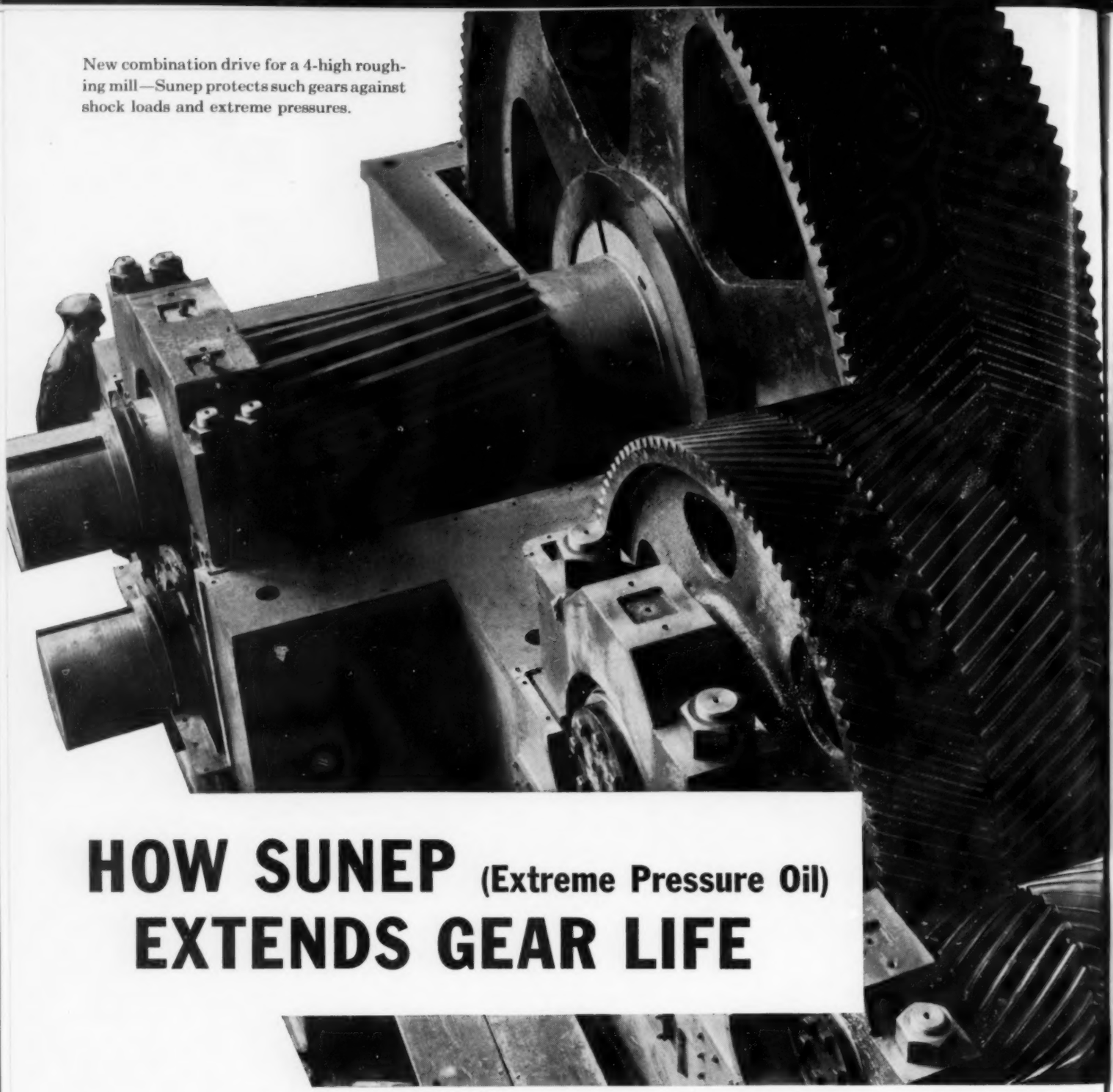


A COPY OF CATALOG GIVING FULL DESCRIPTION AND ENGINEERING DATA SENT UPON REQUEST.

FLEXIBLE COUPLINGS

POOLE FOUNDRY & MACHINE COMPANY

WOODBERRY, BALTIMORE, MD.



New combination drive for a 4-high roughing mill—Sunep protects such gears against shock loads and extreme pressures.

HOW SUNEP (Extreme Pressure Oil) EXTENDS GEAR LIFE

The advantage of running your machines at high speeds and under heavy loads can be quickly lost if your extreme pressure lubricants turn thick, lose film strength, or cause gears to corrode.

Sunep gives your gears better protection longer. Unlike many E.P. oils, Sunep is made from highly refined, premium grade oils skillfully blended with chemical additives that do not drop out during operation or in prolonged storage. This accounts for several rare user benefits: long life at extreme pressures; absence of corrosion—even on bronze; rust protection for steel parts; clean gears and bearings as a result of the oil's high stability.

Primarily a lubricant for enclosed gears, Sunep has proven to be highly effective on bearings and screws working under extreme pressures. Because of its exceptional clinging characteristics, Sunep guards against metal-to-metal contact during the early moments of machine operation after shutdown. FREE BULLETIN. Tells all about Sunep. Get your copy. Write Dept. IS-12

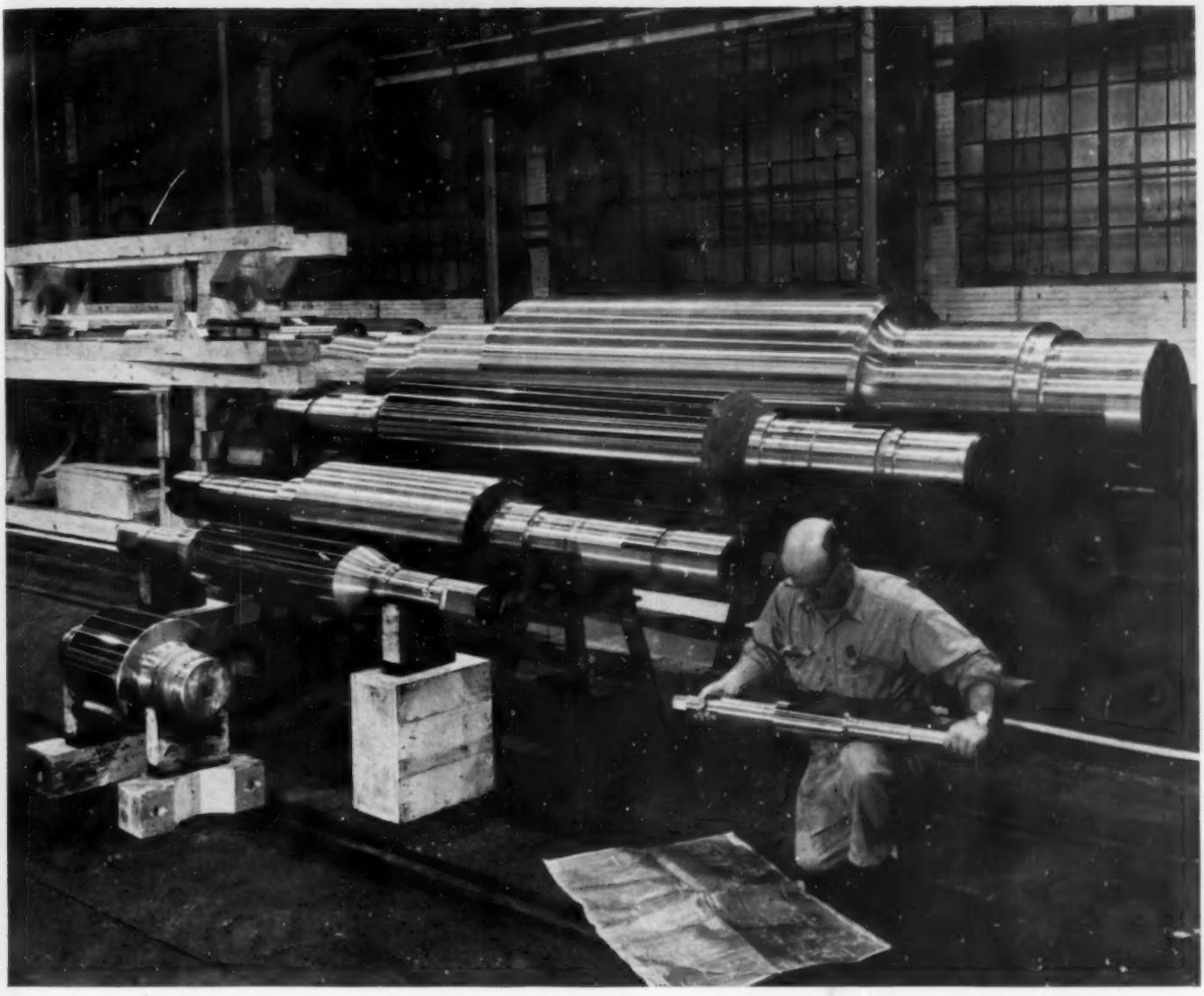
INDUSTRIAL PRODUCTS DEPARTMENT

SUN OIL COMPANY

SUNOCO®

PHILADELPHIA 3, PA. • SUN OIL COMPANY LTD., TORONTO & MONTREAL

Refiners of famous High-Test Blue Sunoco Gasoline



FORGED HARDENED STEEL ROLLS

in the Sizes and Types You Need

When your plant calls for forged steel rolls, make Bethlehem your source of supply.

Bethlehem has been turning out rolls for many years, and nowhere will you find shops better equipped to furnish them. Name your size, name your type, name your finish; we'll take care of the job to specifications.

Shown in the photograph above are six different rolls with some interesting contrasts. The small one, resting across the shop man's knee, weighs only 60 lb. Used for cold-rolling steel strip, it has a diameter of 3.81 in. and an 8¼-in. face. That big fellow in the background, which will hot-roll aluminum slabs, has corresponding dimensions of 38 in. and 96 in.; weighs almost 22 tons.

The other four lie somewhere in between, and they help point up the fact that Bethlehem makes forged rolls for every purpose. Call us when next in the market, won't you? Our engineers will gladly co-operate in working out the details of the job.

SOME OF THE WAYS IN WHICH BETHLEHEM FORGED STEEL ROLLS ARE USED:

Cold-rolling of ferrous sheets and strip

Running-down and finishing operations on copper and brass sheets

Hot- and cold-rolling of aluminum sheets

Cold-rolling of aluminum foil

BETHLEHEM STEEL

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation
Export Distributor: Bethlehem Steel Export Corporation

Newest idea in seamless tube production

Looking for improved methods of tube and pipe making?

At Mannesmann-Meer one of our most recent firsts in mill design is the three-roll arrangement being put to work in stretch reducing mills and continuous mandrel mills. The principle gives smoother outside and inside wall surfaces and better wall tolerances.

But that's only half the story. Along with the three rolls per stand, basic changes in over-all mill design include a revolutionary new mill drive and extremely fast schedule change-over. If you'd like to bring this creative engineering approach to bear on your tube mill plans or problems, why not call on us today? Mannesmann-Meer Engineering & Construction Company, 900 Line Street, Easton, Penna.

M.4.4

MANNESMANN-MEER

World Specialists in High-Speed Tube Mill Machinery

Actually see Rust-Oleum applied directly over sound rusted surfaces in your own plant.

Get proof of performance right in your own plant! See Rust-Oleum 769 Damp-Proof Red Primer applied over *your own* rusted metal after simple scraping and wire-brushing to remove rust scale and loose rust. Rust-Oleum's *specially-processed* fish oil vehicle penetrates rust to bare metal—saving time, labor and money.

Rust-Oleum finish coatings in Aluminum, Gray, White, Black, Orange, Blue, Yellow, Green and others provide both *Rust Prevention and Decorative Beauty!* Specify Rust-Oleum for new construction, maintenance and re-modeling. See Sweet's for catalog and nearest Rust-Oleum Industrial Distributor, or clip coupon to your letterhead . . .

There Is Only One Rust-Oleum. It is as Distinctive as Your Own Fingerprint.

RUST-OLEUM®

STOPS RUST!

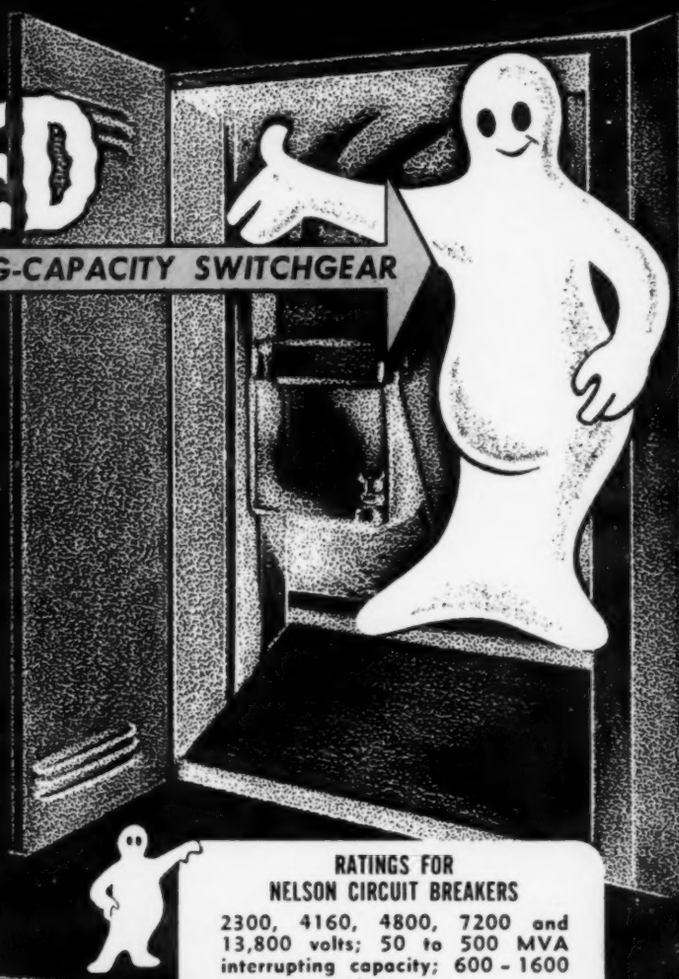
See local classified telephone directory under Rust Preventives or Paints for nearest Rust-Oleum Industrial Distributor.

ATTACH TO YOUR BUSINESS LETTERHEAD AND MAIL TO:
Rust-Oleum Corporation, 2442 Oakton St., Evanston, Ill.

- ☐ Please Show Me the Rust-Oleum "Rusted Panel Demonstration."
- ☐ Test Application of Rust-Oleum Over Rusted Metal Surfaces in My Plant.
- ☐ Complete Literature with Color Chart.
- ☐ Nearest Rust-Oleum Industrial Distributor.

ARE YOU HAUNTED

BY OLD-TYPE, LOW-INTERRUPTING-CAPACITY SWITCHGEAR



Complete replacement of Metal-Clad Switchgear is often hard to justify to management because of its expense; consequently, many engineers are haunted by the dangers of obsolete equipment having low interrupting capacity.

NOW You can put new life into EXISTING CUBICLES

—with a minimum of cost

—with a minimum of trouble

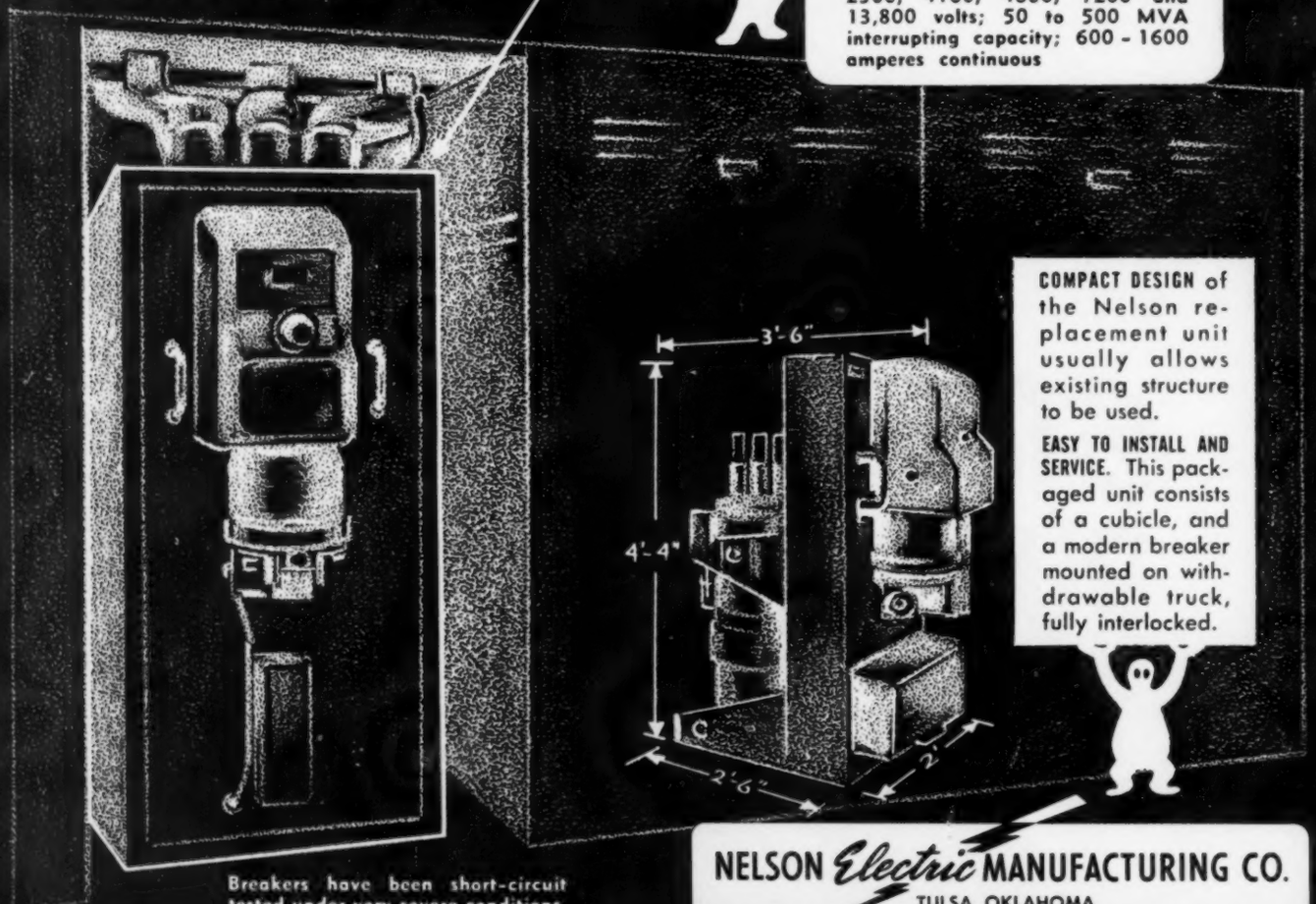
—by installing NELSON REPLACEMENT UNITS

Write for details about this modern, standardized, vertical-lift, metal-clad circuit breaker of proven high interrupting capacity.

RETAIN THE CUBICLE—REPLACE OLD BREAKERS WITH NELSON REPLACEMENT UNITS

RATINGS FOR NELSON CIRCUIT BREAKERS

2300, 4160, 4800, 7200 and 13,800 volts; 50 to 500 MVA interrupting capacity; 600 - 1600 amperes continuous



Breakers have been short-circuit tested under very severe conditions.

COMPACT DESIGN of the Nelson replacement unit usually allows existing structure to be used.

EASY TO INSTALL AND SERVICE. This packaged unit consists of a cubicle, and a modern breaker mounted on withdrawable truck, fully interlocked.

NELSON *Electric* MANUFACTURING CO.

TULSA, OKLAHOMA

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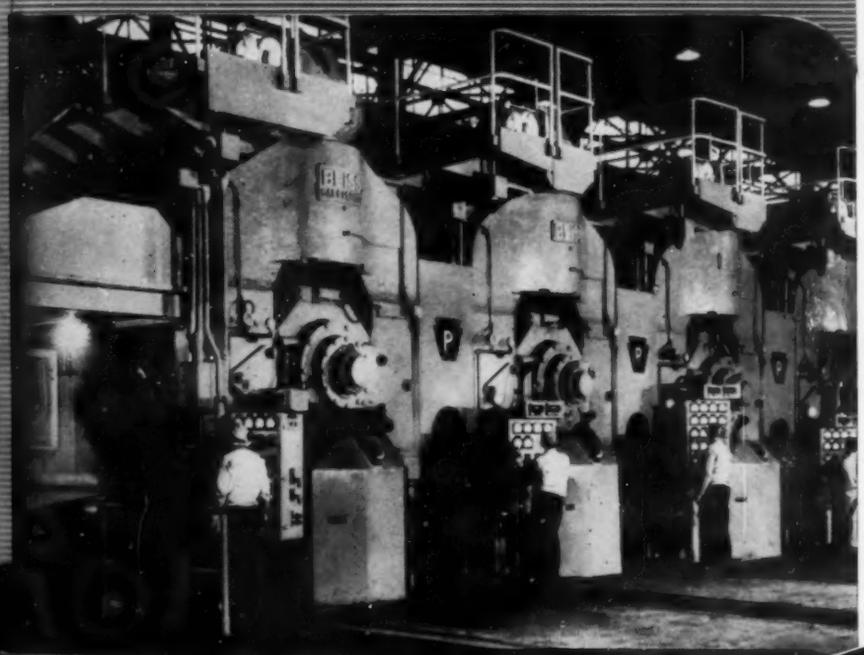
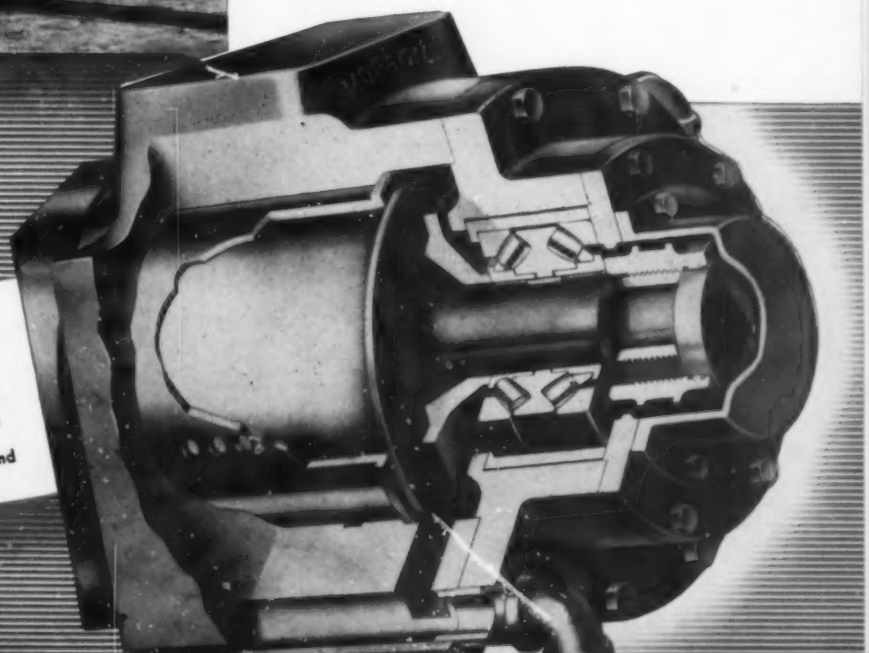


Hot Mills or Cold Mills **MORGOILS** give Top Performance

In the modern Allenport plant of Pittsburgh Steel Co. both the Hot Mills and Cold Mills roll on MORGOIL BEARINGS.

Whatever the rolling requirements MORGOIL equipped mills excel in performance and low maintenance costs.

MB-28



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WORCESTER, MASSACHUSETTS

Rolling Mills - Morgoil Bearings - Wire Mills
Regenerative Furnace Control - Ejectors - Gas Producers

English Rep., International Construction Co., 56 Kingsway, London W. C. 2, England

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guides the steel industry

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bar, hoop, strip, shape
mill guides; and rollers

SEAMLESS TUBE MILLS:
guide shoes, rolling
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rolls, tool holders, etc.

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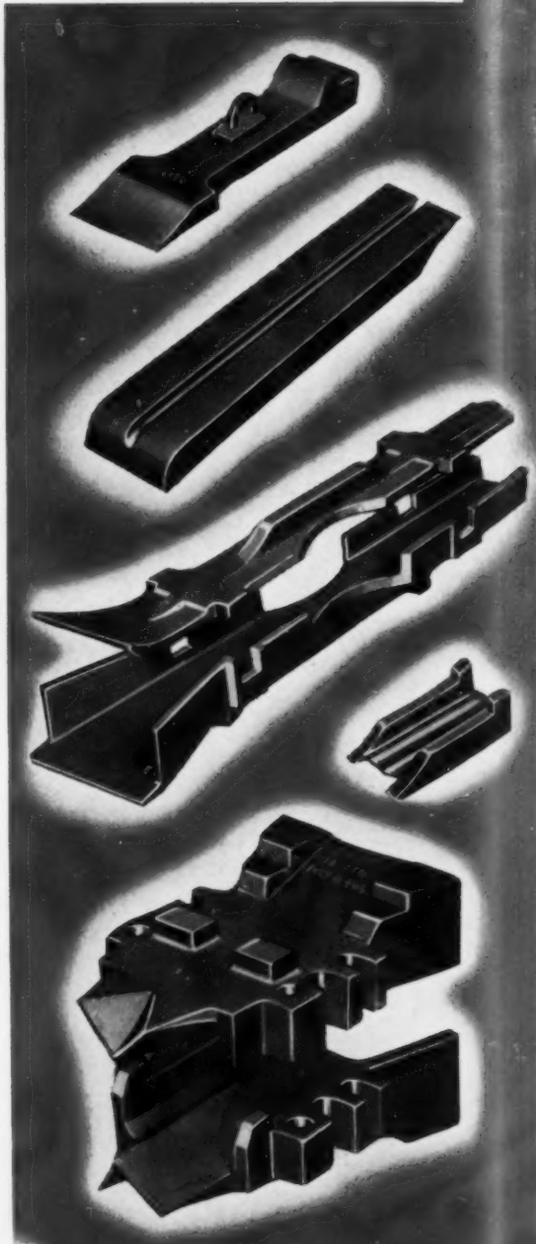

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ONE OF A KIND... *For a Reason!*

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This Heyl & Patterson 8-ton capacity Unloading Bridge now operates at the new Weed Heights, Nevada plant of the Anaconda Copper Mining Company. A Heyl & Patterson Loading Bridge and a Heyl & Patterson Gantry Crane also function at this new plant.

This Unloading Bridge was specifically designed and built by Heyl & Patterson to perform one definite function for Anaconda Copper Mining Company . . . to dig tailings from the leaching vats at Anaconda's new Weed Heights, Nevada plant and load these tailings, by way of a hopper, into trucks for disposal.

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When *your* problem centers around the handling and transportation of ore, coal or other heavy bulk materials . . . the wisest move you can make is to consult Heyl & Patterson, specialists in this field for over 60 years.

Heyl & Patterson has the complete facilities necessary to answer your Heavy Bulk Materials Handling problem. We have our own engineering department . . . our own machine shop . . . our own research department . . . and our own service department.

Call on Heyl & Patterson to help you. An experienced Heyl & Patterson engineer will gladly talk over your problem with you at no obligation.

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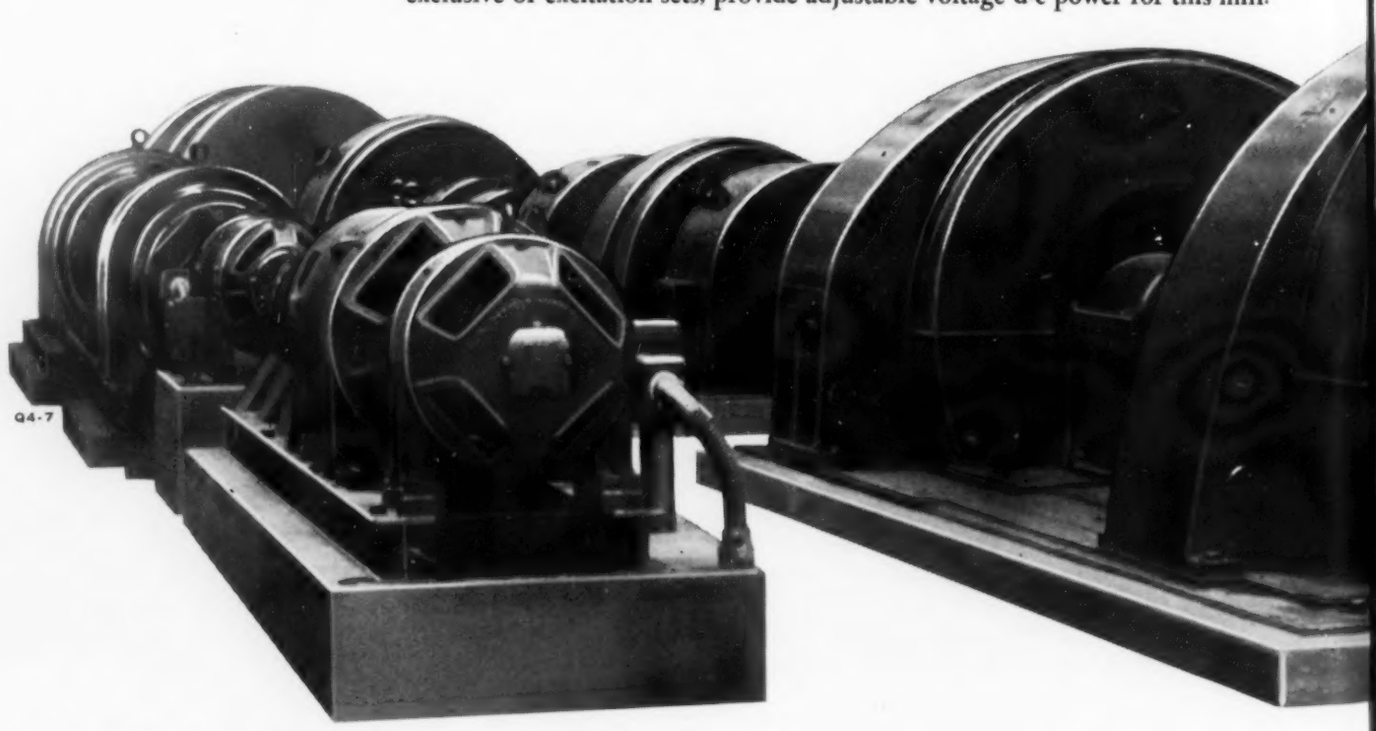
55 FORT PITT BLVD. PITTSBURGH 22, PA.

Heavy Bulk Materials Handling Equipment

All The Way from Design to Erection

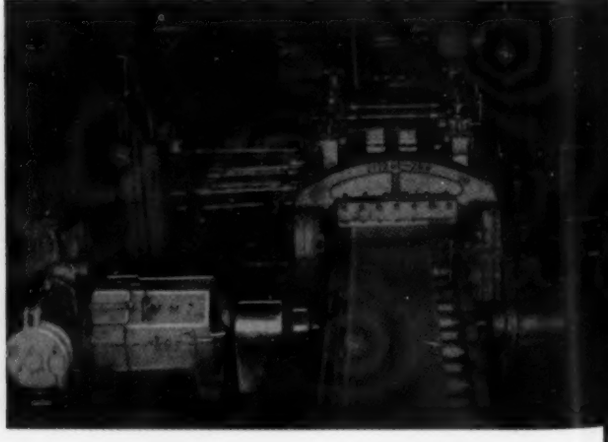
In Lone Star's new pipe mills ...all electric

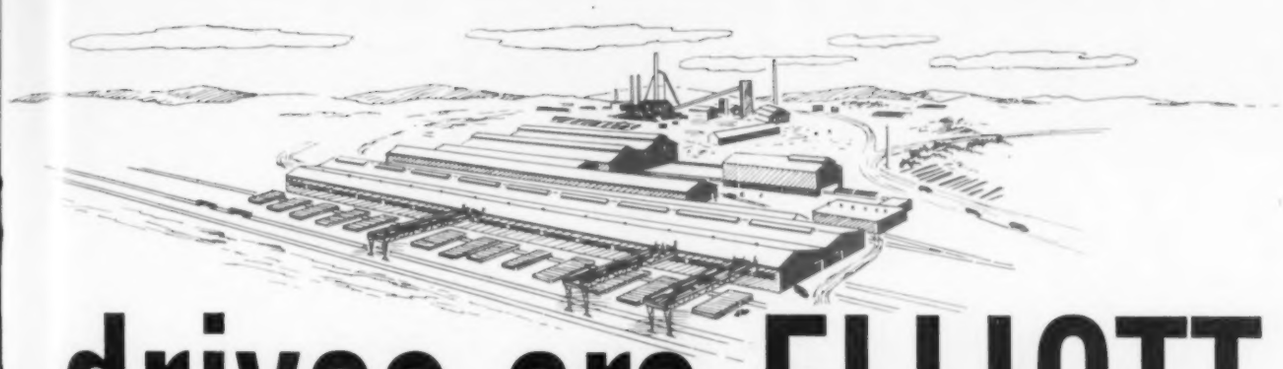
In this group of motor-generator sets, the 4500-hp weld power set for the No. 1 mill is seen in the right foreground. Three additional Elliott m-g sets, exclusive of excitation sets, provide adjustable voltage d-c power for this mill.



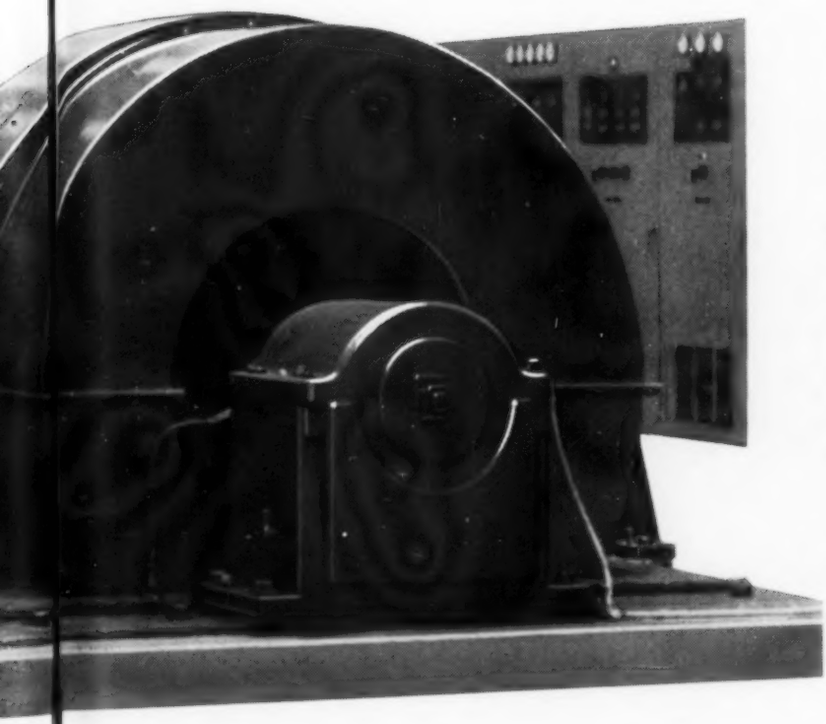
The forming section of the larger mill from the entry end. Drives include eight Elliott Crocker-Wheeler 75-hp, 1150/1440-rpm d-c motors. At right is a 15-hp, 1800-rpm totally-enclosed fan-cooled motor driving hydraulic pump.

Exit end of entry section of the leveller and up-cut shear. An Elliott C-W 50-hp mill motor may be seen at the left.





drives are ELLIOTT



The new plant of Lone Star Steel Company, Lone Star, Texas, is a completely integrated steel mill with its own furnaces, rolling mills and two modern electric resistance weld pipe mills. All electric drives for the pipe mills were supplied by Elliott. Ten Elliott adjustable-voltage d-c generators, totalling nearly 3000 kw, supply the drive power. Two Elliott single-phase alternators, one rated 4000 kva, 2400 volts, 84 cycles, supply the weld power. An Elliott 4500-hp, 13,200-volt synchronous motor drives this larger alternator. More than 500 Elliott a-c and d-c motors are used, these ranging in size from this 4500-hp machine down to small motors, for a total horsepower rating of nearly 15,000.

Elliott steel mill rotating equipment is at home here and in mills everywhere. Elliott design and construction excellence, plus experienced application engineering, makes Elliott a source for your consideration. Ask your nearest Elliott District office for a copy of the new illustrated Bulletin — "Elliott Equipment for the Steel Industry" or write Elliott Company, Jeannette, Pa.

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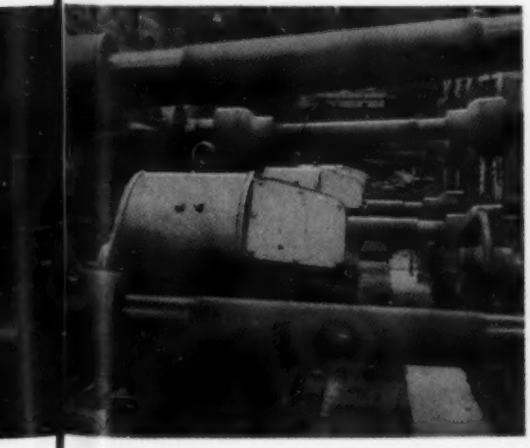
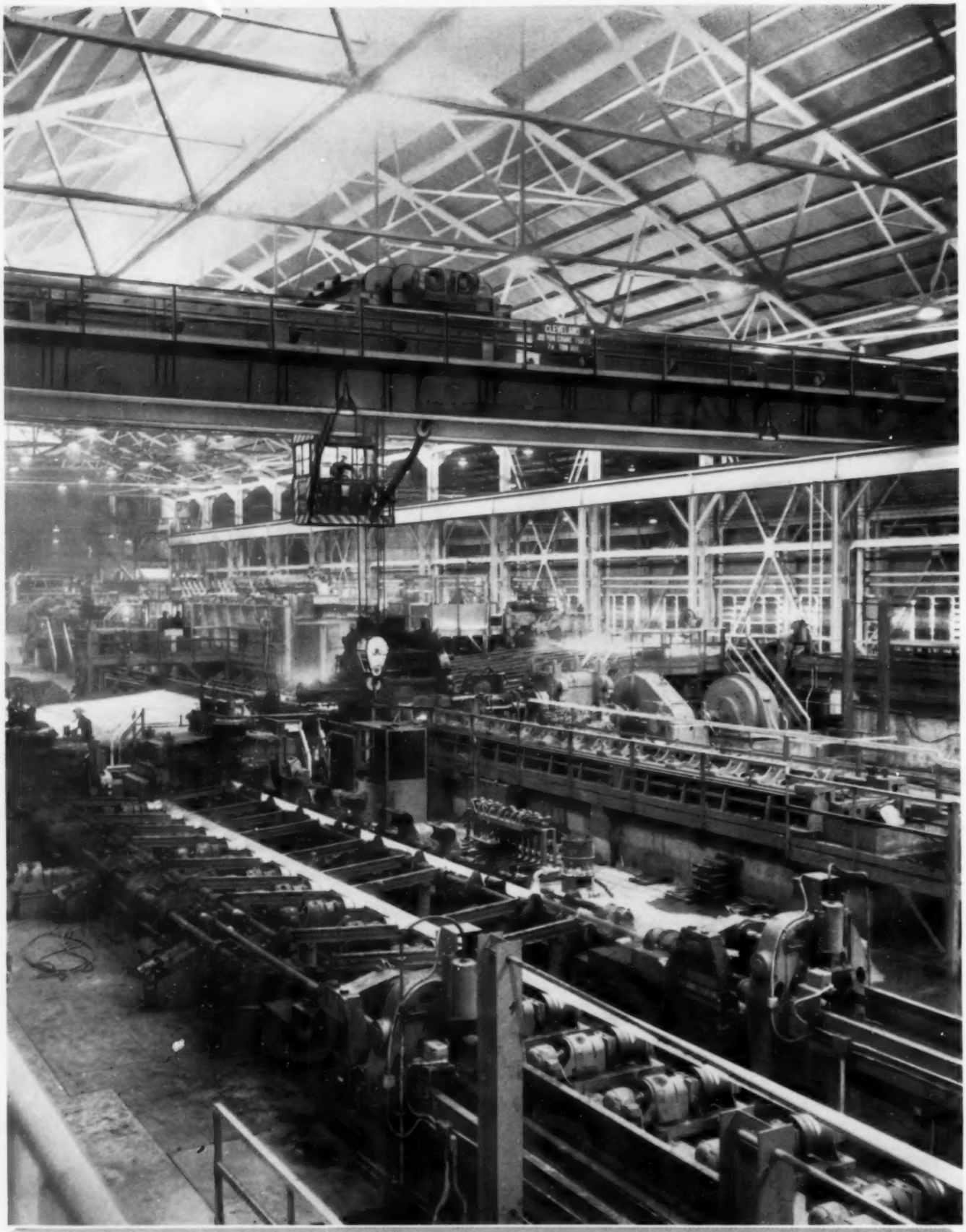
STEAM TURBINES • MOTORS • GENERATORS • DEAERATING HEATERS • EJECTORS • CONDENSERS • CENTRIFUGAL COMPRESSORS • TURBOCHARGERS • TUBE CLEANERS • STRAINERS

A view showing four 25-hp, 1150/1440-rpm d-c forming section drive motors on the smaller mill.



The pipe conveyor of the No. 1 mill is driven by a line of Elliott C-W 1-hp, 1750-rpm d-c motors.

This pipe conveyor is driven by a line of Elliott C-W 1-hp, 1800-rpm enclosed induction motors.



CLEVELAND CRANES

MODERN ALL-WELDED STEEL MILL CRANES

5031 EAST 289th ST.
WICKLIFFE, OHIO

Crops *and* Shorts

BENJAMIN F. Fairless, chairman of United States Steel Corp., told the Alabama Chamber of Commerce that 1955 should be a year of moderate gains all along the line, and that for the long term outlook, we are "at the gateway of what promises to be a great scientific revolution."

Mr. Fairless looks for steel production to run 91,000,000-96,000,000 tons in 1955, and he believes an investment of $300,000,000,000 "necessary in the next 20 years for new plants, new facilities and new lines of production not even in existence today, in order to keep abreast of the needs of a growing population."

▲

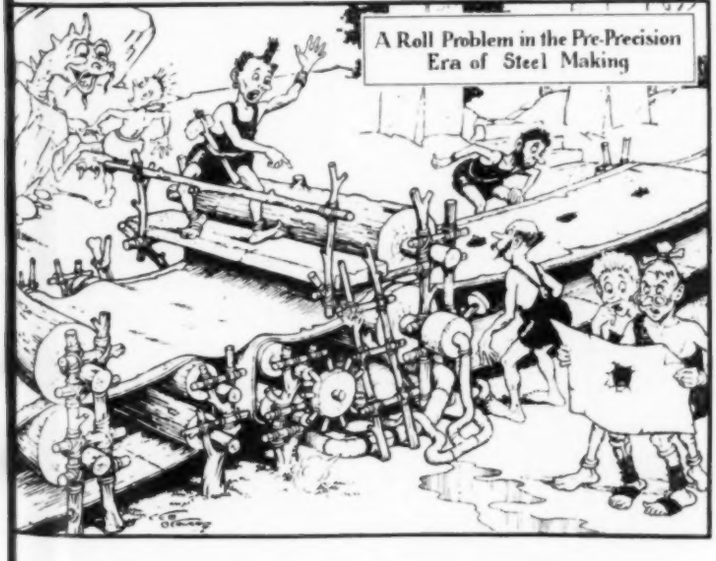
IN the same vein, Avery C. Adams, president of Pittsburgh Steel Co., looks for an operating rate of 90 per cent by next February and a 1955 production of 105,000,000 tons of steel.

▲

PERHAPS it's the holiday season, but we like this way of preparing spinach: Chop the spinach fine, mix it with coarse cereal, put it in a wire pen, wait until it turns to turkey meat, roast and serve with cranberry sauce.

▲

THE drawing below was sent in sometime ago by an AISE member who just wanted to point out that, in the mills, troubles are ever with us. We've tried without success to find the original source of the drawing in order to give due credit. Also, we wanted to find out which one of the characters is the industrial engineer.



▲

ONE of our good friends says that when you're young, you do a lot of wishful thinking, but as you grow older you do a lot of thoughtful wishing.

▲

OF the total of 83,106,191 motor vehicles in the world (one of every 29 population), the U.S.A. has 56,313,281 of them (one for every 2.8 population).

▲

MORE than 5000 industrial organizations employ 250,000 scientists and have spent more than $10,000,000,000 for scientific research since World War II.

▲

MAYBE the years are getting shorter or maybe age makes them go faster, but it's time again to say — MERRY CHRISTMAS AND A GOOD NEW YEAR TO ALL.

▲

TYPICAL of the immaturity that still exists in too many unions and too many union leaders are the strike threats of the United Automobile Workers' Walter Reuther. The threats were made in making new demands on the automobile industry, although present contracts run until next summer, bargaining had not opened and demands had not even been formally presented to the companies.

▲

GOOD advice from the Wall Street Journal:

A Wife's New Hat
You don't have to like it
Though that would be nice
But notice it, brother!
That's my advice.

▲

THE 36-hour work week is receiving serious consideration in some quarters. That will mean 4½ days — Friday afternoon off. More leisure means more time to spend money, so everyone will need a raise.

▲

E. T. Weir, chairman of National Steel Corp., estimates that in the next 45 years the population of the United States will increase to 300,000,000 people, which will mean that the steel industry will need at least an additional 75,000,000 tons of annual steelmaking capacity to provide the same per capita consumption of steel that is available today. This means an average yearly addition of about 1,700,000 tons of capacity. This, of course, is in addition to replacement of obsolete facilities.

▲

A correspondent tells us a sensible girl is more sensible than she looks because a sensible girl has more sense than to look sensible.

Instruments guide industrial waste treatment

Industry knows that *water*, once taken for granted, has become a precious raw material in all too short supply. Guarding against stream pollution is more than an altruistic plan to make life happier for fish.

Waste treatment is as much a part of the over-all production operation as stamping, machining, or mixing of raw materials. The advancing technology of waste treatment now recognizes the problem as one of *chemical engineering*. The same techniques that have sparked progress in process operations are being successfully integrated in the operation of efficient, automatic waste treatment systems.

Engineered Honeywell control

Manually-regulated, batch-type waste treatment systems are fast giving way to fully automatic, continuous processes which make full use of dependable Honeywell instrumentation . . . including the same advanced controls which have outstanding records in scores of industrial operations. With pinpoint accuracy, round-the-clock precision, instruments analyze chemical concentration and automatically adjust the addition of reagents . . . provide a permanent record of effluent characteristics, positive evidence of operating performance. The waste treatment process runs continuously with increased throughput, reduced storage capacity, and minimum operating costs.

Outstanding economies

The many plants where waste treatment operates under control of Honeywell engineered instrumentation report:

- Lower construction costs; equipment can be designed smaller . . . much storage capacity even eliminated.
- More consistent, more satisfactory operation.
- Reduced operating and maintenance costs.
- Considerable chemical savings.
- Reduced costs of laboratory analysis.
- Elimination of damage due to equipment overloads.

The experienced Honeywell staff will work with you . . . or with your consulting engineers. Call in your local Honeywell sales engineer . . . he's as near as your phone.

Flexible control assures precision in annealing

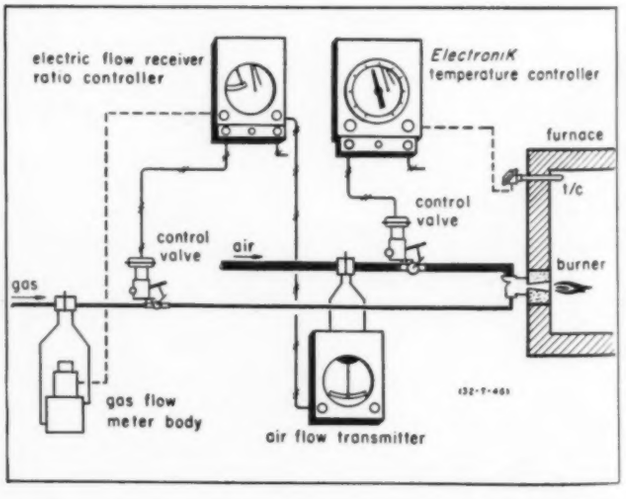
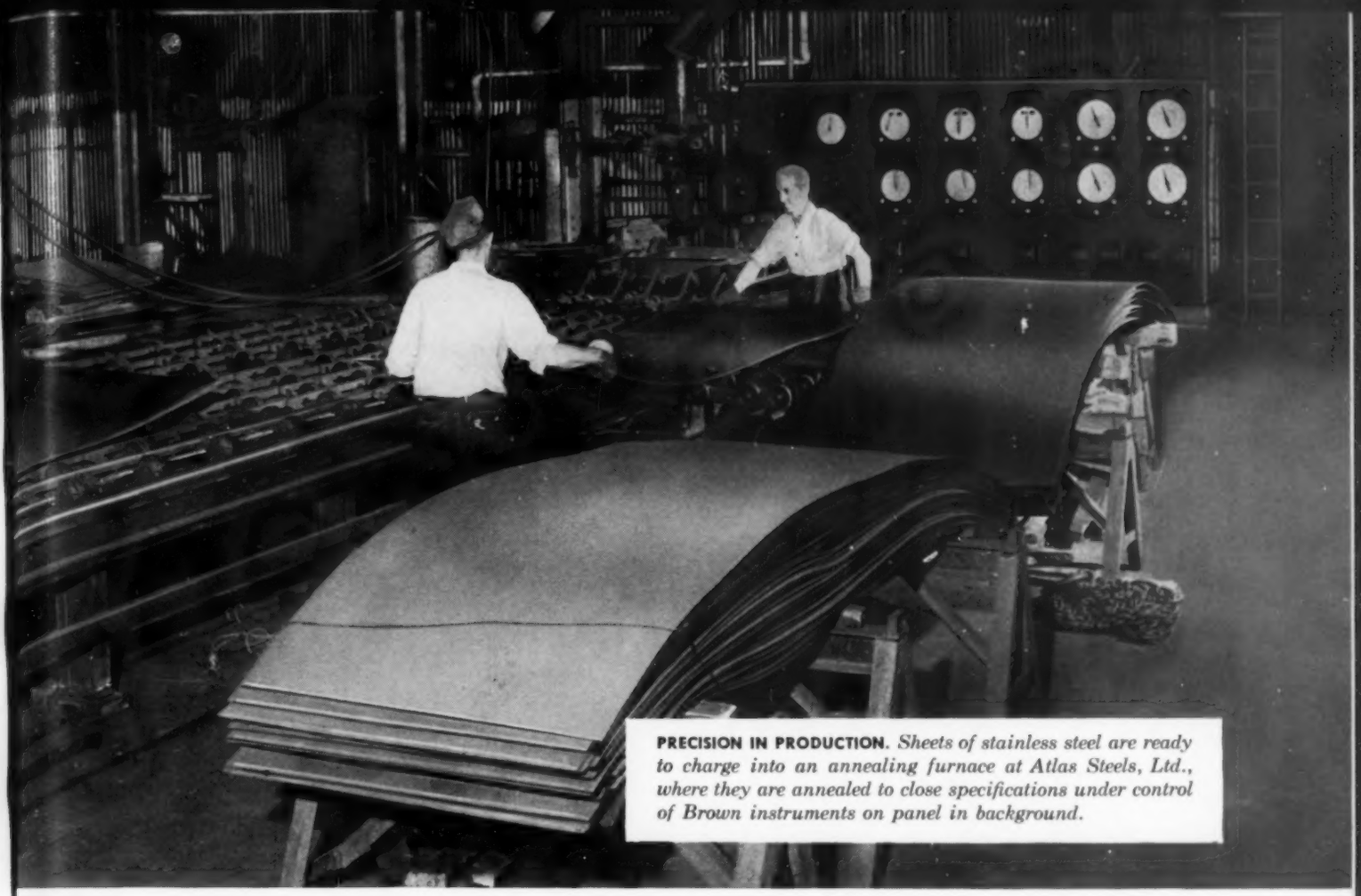


Diagram shows coordinated temperature and fuel-air ratio control system for one of the zones of the annealing furnace.



PRECISION IN PRODUCTION. *Sheets of stainless steel are ready to charge into an annealing furnace at Atlas Steels, Ltd., where they are annealed to close specifications under control of Brown instruments on panel in background.*

stainless sheet at Atlas Steels

ATLAS STEELS, LTD., one of the British Commonwealth of Nations' largest producers of quality steels, makes good use of modern Brown instrumentation in the production of many stainless, high speed and special purpose alloys. The accurate, flexible regulation of temperatures and fuel-air ratio obtained by custom-engineered control systems plays an important part in maintaining consistently high quality and economy.

A big sheet annealing furnace, for example, is equipped with coordinated control for each of four zones. Three zones are gas-fired, and the fourth is oil-fired. For each, a team of Brown instruments automatically holds furnace firing to exact specifications. An *ElectroniK* potentiometer, working with a platinum thermocouple, actuates the combustion air valve to hold constant temperatures. An air flow controller, using a bell-type meter body especially suited to low pressures, meters combustion air flow and resets the control index of a Brown flow ratio controller. This third instrument, in turn, regulates the gas or oil fuel valve . . . holding fuel-air ratio in accurate proportion at all firing rates.

The exact control thus obtained not only gives Atlas Steels the temperature precision essential to annealing of critical alloys, but also assures efficient utilization of fuel in this vital production operation.

Whether you're installing new furnaces or modernizing old ones, it will pay you to investigate the ways that Brown instrumentation can add to performance. Your nearby Honeywell sales engineer will be glad to discuss your specific problem . . . and he's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.

● **REFERENCE DATA:** Write for Catalog 1531, "*ElectroniK* Controllers," and for Data Sheet No. 4.3-4a, "Fuel-Air Ratio Controllers."

MINNEAPOLIS **Honeywell**

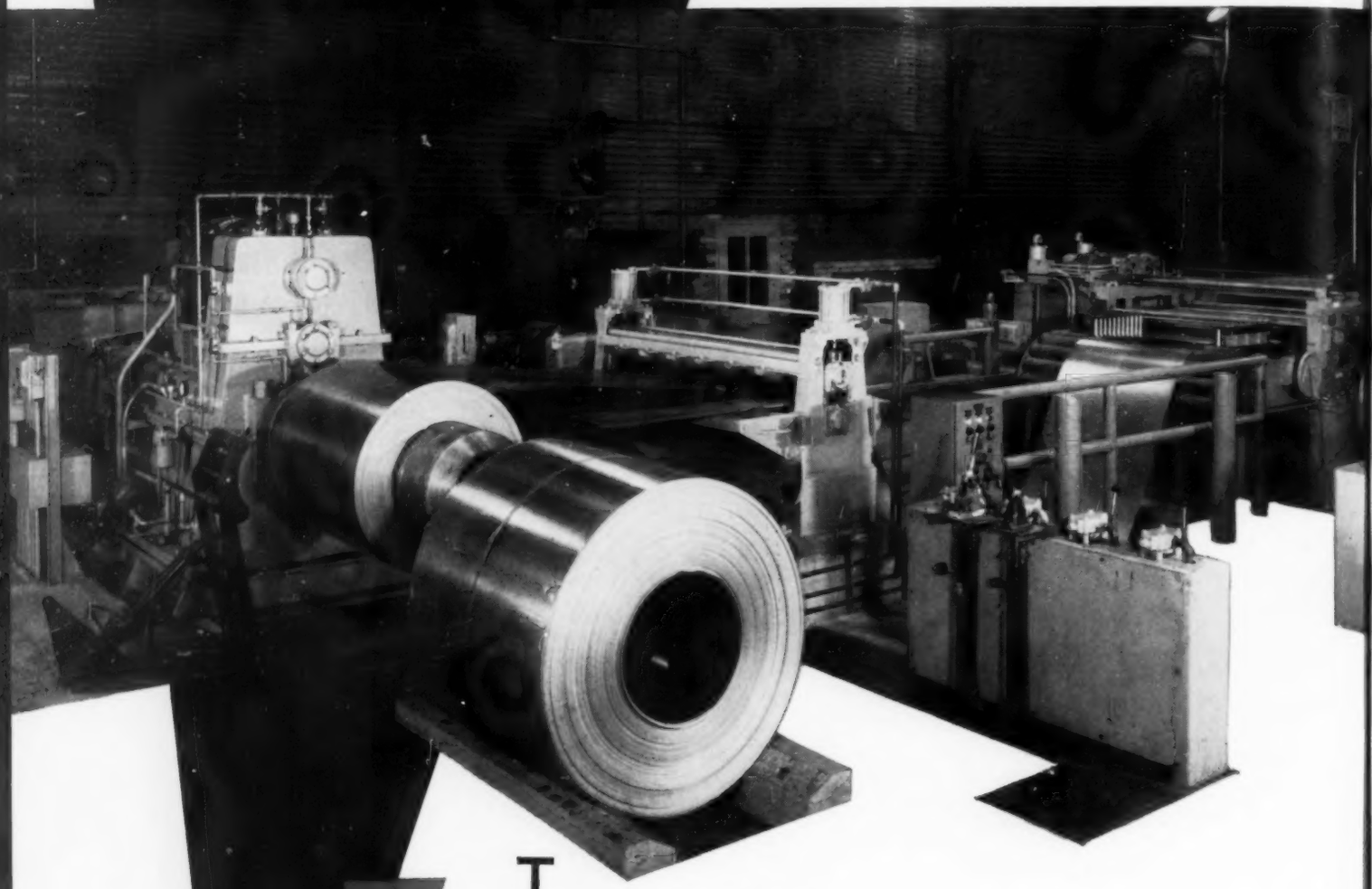
BROWN INSTRUMENTS

First in Controls

The WEAN

Engineering Company Inc.

Warren, Ohio . .



THE Wean Engineering Company, Inc., Warren, Ohio, is a recognized specialist in the design and installation of sheet, tin and strip mill equipment. The expert knowledge and trained imagination of one of the world's most noted steel mill engineering firms is at your service when you specify Wean — whether the job calls for a single piece of equipment or a complete design of an entire line.

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Iron and Steel ENGINEER

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In This Issue

Patent Reviews — By Melvin Nord, Patent Attorney, Detroit, Mich..... 21
Increasing Rod Production by Conversion of a 2-Strand Rod Mill to 3-Strand Operation — By C. H. Burden, Chief Project Engineer and W. E. Zelley, Divisional Plant Engineer, John A. Roebling's Sons Corp., Trenton, N. J..... 55
Modern Manufacture and Use of Cast Rolling Mill Rolls — By F. H. Allison, Jr., Vice President and C. E. Peterson, Sales and Research Metallurgist, Rolls Division, Blaw-Knox Co., Pittsburgh, Pa..... 68
Application of Lubricants to Rolling Mills — Problems, Developments and Trends — By Wayne G. Ritter, Trabon Engineering Corp., Pittsburgh, Pa..... 78
Coke and By-Products in 1953 — By I. E. Madsen..... 87
Philadelphia Regional Safety and Fire Conference —
Selling Safety — By Walter L. Jones, Jr., Safety Engineer, Alan Wood Steel Co., Conshohocken, Pa..... 96
Safety in Operations — By C. E. Pritchard, Superintendent of Mills, Alan Wood Steel Co., Conshohocken Pa..... 97
Surveying for Safety — By J. B. Quesnel, Safety Engineer, Bethlehem Steel Co., Sparrows Point, Md..... 101
Electrical Power Distribution and Utilization at Lone Star Steel Co. — By R. G. Orthwein, Chief Electrical Engineer, A. J. Boynton & Co., Chicago, Ill..... 104
Engineering Conception of Fairless Works — By J. D. Rollins, Assistant Vice President — Engineering, United States Steel Corp., Pittsburgh, Pa. 115
Maintenance of Slag Bottom Soaking Pits — By John A. Warchol, Jr., Supervisor, General Labor, Lukens Steel Co., Coatesville, Pa..... 121
Carpenter Steel Installs Multi-Purpose Hot Rolling Mill..... 126
J & L Adds Facilities to Tube Department..... 130
Instrumentation at Fairless Works — By H. L. Russell, Instrumentation Engineer and F. R. Ross, Project Engineer, Industrial Div., Minneapolis-Honeywell Regulator Co., Philadelphia, Pa..... 134
Silver Bay Plant will Pelletize Taconite Concentrates..... 141
Date-Line Diary..... 163
Industry News..... 171
Personnel News..... 183
Publication Service..... 195
Equipment News..... 203
Book Reviews..... 210
AISE Yearly Index..... 213
Index to Advertisers..... 219

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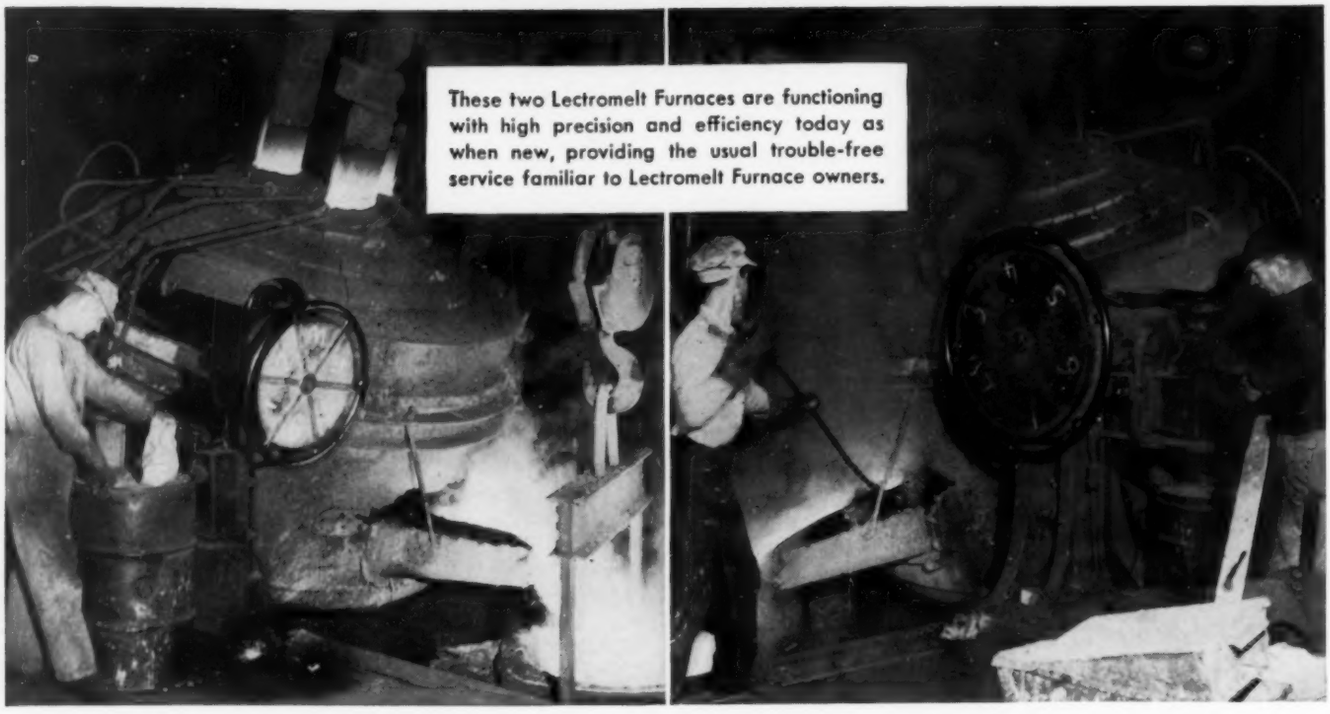

These two Lectromelt Furnaces are functioning with high precision and efficiency today as when new, providing the usual trouble-free service familiar to Lectromelt Furnace owners.

MORE THAN 80,000 HEATS SINCE 1918

MORE THAN 35,000 HEATS SINCE 1942

. . . at Farrell-Cheek Steel Company, Sandusky, Ohio

Thirty-five years of experience, engineering and research, and an understanding of your melting needs go into every Lectromelt* Furnace. Each new idea is proved in actual production at several installations before being applied as part of Lectromelt design.

With more electric furnaces in successful operation throughout the world today than any other manufacturer, Lectromelt engineers qualify to build the most modern, practical electric arc furnaces.

If you are considering purchase of a new electric furnace, be confident that a new Lectromelt Furnace will give you high performance and efficient operation long after your investment is amortized. Ask a long-time operator of Lectromelt Furnaces, like Farrell-Cheek, about the quality of Lectromelt equipment.

Write for the Lectromelt Furnace Bulletin No. 9. Pittsburgh Lectromelt Furnace Corp., 310 32nd Street, Pittsburgh 30, Pa.

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MOORE RAPID

WHEN YOU MELT... *Lectromelt*

INCREASING ROD PRODUCTION

by Conversion of a

2-Strand Rod Mill to 3-Strand Operation

C. H. BURDEN

By C. H. BURDEN
Chief Project Engineer
and
W. E. ZELLEY
Divisional Plant Engineer
John A. Roebling's Sons Corp.
Trenton, N. J.

W. E. ZELLEY

. . . . an ingenious roll mill conversion program gave increased production economically with a minimum of disturbance to operations . . . .

▲ **DURING** March 1929, the John A. Roebling's Sons Company built a new rod mill at the Roebling, N. J., Works for the purpose of rolling 2 × 2-in. billets into rods suitable for drawing into finished wire.

This mill was originally designed to roll two rods of 0.187 in. diam (No. 6) up to and including 0.360 in. diam rounds as a maximum, with a delivery speed of approximately 4000 fpm when finishing the smaller sizes with a capacity of 20 tons per hour.

As originally installed, the mill consisted of a 25 × 30 ft billet heating furnace fired with producer gas which was generated in a producer located close by the furnace in the west end of the mill. Immediately adjacent to the furnace, there was a roughing mill consisting of four sets of 14-in. rolls and four sets of 12-in. rolls followed by a flying shear for end cropping then by an intermediate roughing mill of four sets of 12-in. rolls, both of these mills being geared to a single 2500-hp, 600-volt, d-c motor, 180/450 rpm.

Following the intermediate rougher, there was a loop section, then a 2-stand intermediate mill with 12-in. diam rolls directly geared to a 600-hp, 300/700-rpm motor, after which the rods were passed through a wide looping table to one or the other of two parallel finishing mills each consisting of six 9-in. roll stands geared to a 800-hp, 469/750-rpm motor.

At the exit end of the finishing mill, the rods from each mill were alternately switched to one or the other of two pouring reels associated with each finishing mill. These reels were equipped with a 50-hp motor each that was used only for acceleration and deceleration, the actual drive during reeling being from the mill by means of gears and an electrically operated clutch that tied the mill drive to the reel shaft and disconnected the motor electrically, allowing it to float on the mechanical drive until the reeling of a rod was completed after which the clutch was opened and the motor brought the reel to a stop by means of dynamic braking.

This drive was necessarily limited in its range as it was necessary to change gears whenever finishing from any stand other than No. 20 and whenever the roll size at the finishing stand was any size other than the normal size for that stand.

Figure 1, a layout of the mill shows diagrammatically the mill as it was installed. As briefly mentioned previously, the heating of billets was accomplished in a producer gas fired furnace which during the 1930's was converted to oil firing using multiple low pressure, air-atomized burners located in the front wall above the hearth and eliminating the stoves formerly used to preheat the air for combustion.

With this change, no difficulty was encountered in heating over 30 tons per hour when rolling the larger sizes of rods and flats, which by this time had become a standard product of the mill.

This arrangement of the mill, including the furnace and mill equipment, gave very satisfactory results over a period of many years, but the need for increased production in the war years and immediately thereafter made it necessary for a study to be made of the possi-

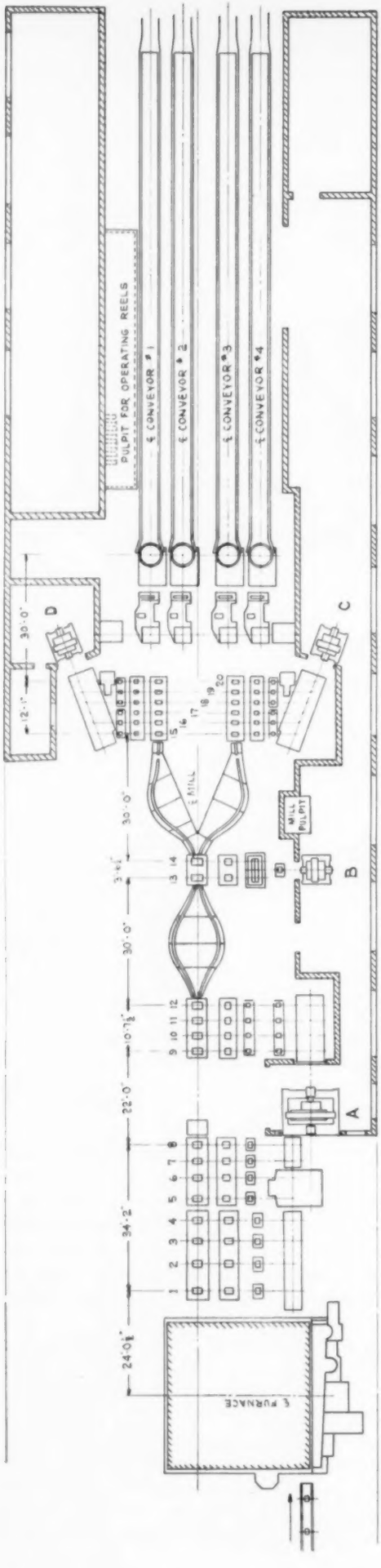


Figure 1 — Sketch shows general layout of wire rod mill before conversion.

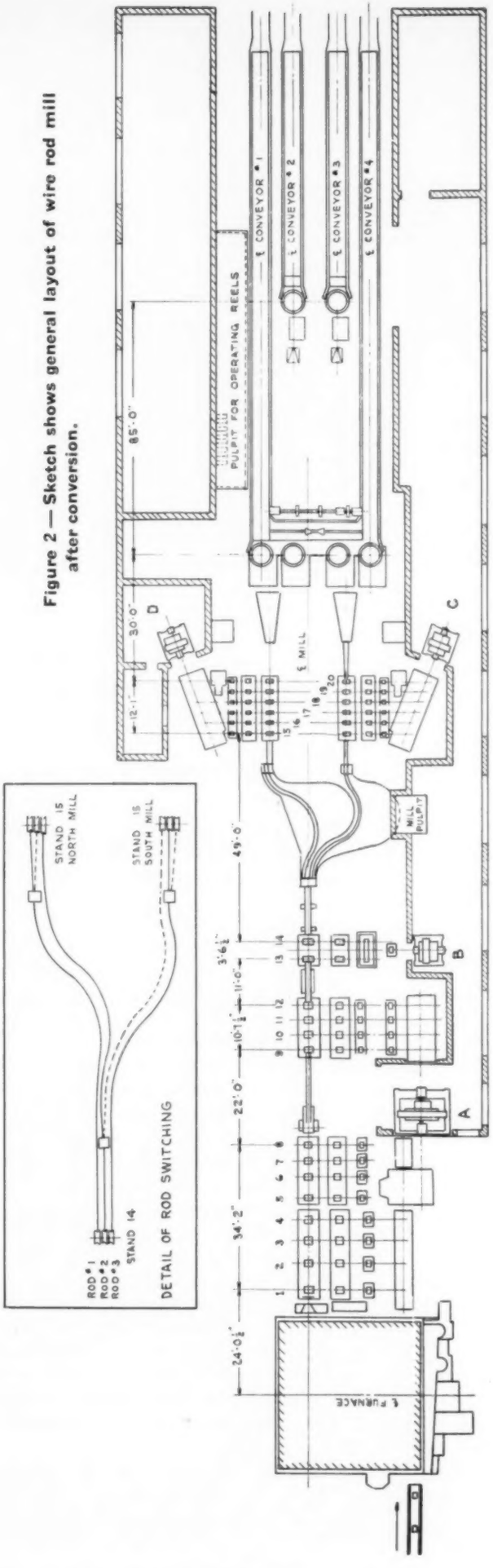


Figure 2 — Sketch shows general layout of wire rod mill after conversion.

bilities of increasing our rod rolling capacity in either one or the other of two methods — build a new mill, or increase the capacity of our present mill.

A survey of our rod production revealed that a large percentage of the rods rolled were in sizes No. 5 and No. 6 or 0.218 and 0.187 in. diam respectively, and that if we could arrange to increase the capacity of the mill in these sizes from 20 to 30 tons per hour, we would get a net increase of mill capacity of 35 to 40 per cent based on the mix of orders received.

This increase in production was possible in the smaller sizes but in larger sizes where the tons per hour rolled were higher, it was thought that difficulty might be encountered in heating the billets.

Continued study of our requirements clearly indicated that the expected production increase could meet our current demands and would be sufficient to meet our expected demand for several years to come.

As the increasing of the capacity of our present mill promised to be far less costly and certainly more readily obtained in view of the long deliveries of both mechanical and electrical equipment, it was decided that we should eliminate any consideration of building a new mill and concentrate on the improvement that could be made to the existing mill.

Careful studies of the power required by each of the main mill motors showed that sufficient power was available from the 2500-hp motor driving the roughing mill and the 600-hp motor driving the intermediate mill to handle an increase of 50 per cent in the mill load, and that the finishing mill motors could drive their respective mills while rolling two rods without exceeding the RMS rating of the motors.

The gears driving the mill stands were checked for capacity and found to be adequate for the increased loading to be imposed upon them though they could be expected to wear at a faster rate and would have to be watched.

Having arrived at the decision, the plan was far from complete as many details were still to be settled. The increasing of the capacity of a rolling mill by rolling more bars simultaneously had been accomplished in several mills before this one, but most of them were able to do it by increasing the number of bars and with no increase in the number of reels required.

One of our problems was to devise a method which would give us equal or nearly equal wear in the several grooves of the finishing mill rolls as well as well-distributed wear across the other rolls in the mill.

The plan finally adopted is shown in Figure 2.

It was decided that three simultaneous rods would be carried through stands 1 through 8 on 6-in. centers and stands 9 through 14 on 7½-in. centers and that the center rod would be automatically switched at the exit side of stand No. 14 to either of the two finishing mills; the first rod being finished on the south mill and as that rod passed the switch point the switch would divert the following rod to the north finishing mill and repeat the action as each rod passed this point.

The left hand rod from the roughing mill always goes to the north finishing mill and is switched at the entry side of stand No. 15 to alternately one or the other of two finishing passes, and similarly the right hand roughing mill rod always goes to the south finishing mill and is switched to one or the other of two passes in that mill.

Thus, it is seen that each finishing mill will handle half of the rods rolled and that each of the three passes used in the finishing mill will be required to roll one-third of the rods rolled in that mill, thus equalizing the wear and enabling more uniform rod rolling.

The two center rod muffle conveyors were shortened and two new reels were installed in the area vacated by this move and a cross conveyor was designed and installed to allow the two center reels to discharge rods to the outside muffle conveyor. This cross conveyor was electrically interlocked with all the existing reels, strippers, and conveyors to prevent mill delays.

This doubling-up of the amount of rods being handled by each of the outside conveyors and the shortened length of the center conveyors made it necessary to supply some method of increased cooling of the rods and that will be described in more detail later.

The existing reels as previously mentioned were driven from the mill by gears and shafting using the motors only for acceleration and stopping the reels for stripping, but the new reels were to be located at considerable distances making a direct drive very complicated. It was decided, therefore, to install two variable voltage motor-generator sets each of which was to supply the current for the three reels connected to each finishing mill and to install fully automatic control to synchronize the reel speeds to the mill speed.

Having decided on the plan to be followed, it remained to work out the details of switching and controls and a schedule of installation which would give the earliest completion of the project with the least interruption to operations. This was particularly important as at that time rolling was on a full schedule and mill outages had to be kept to a minimum.

At this point, the writers wish to express their appreciation for the complete cooperation given by the equipment suppliers in supplying the necessary mill design details, and much of the mechanical equipment, and his help which enabled carrying out the plans to the desired end result.

The initial plans for this project were developed in December 1950 and called for a new billet switch and toggle shear between the preheating furnace and Stand 1, a new flying shear after Stand 8, a new three-strand repeater between Stands 12 and 13, two new two-strand repeaters between Stand 14 and each of the finishing mills, two new snap shears, a new cross conveyor, two new pouring reels and new rest bars and guide boxes throughout the mill.

While some of these items were more or less standard with our supplier, others required extensive design, detailing, and pattern making before fabrication could start with consequent longer deliveries than we cared to contemplate. This applied particularly to the three repeaters mentioned and the cross conveyor.

Accordingly conferences were held with the supplier to explore ways and means of improving deliveries in any way possible and as a result of these discussions the layout was modified somewhat from the original concept and, at the same time, we undertook to furnish engineering and manufacturing assistance on some items which would result in materially speeding up the installation program.

On this basis, the project received our management's approval and was given the green light in January 1951.

One important modification resulted from the conferences when it was brought out that if Stands 13 and 14 and their drive gearing and 600-hp drive motor were to be moved five feet back toward the intermediate roughing mill, it would be possible to fit in a double deck forward running repeater for which designs and patterns already existed and which was successfully operating on another mill with split finishing mills. This repeater would have the further advantage of looping away from the operating side of the mill thus leaving more clear mill floor.

The delivery time to be saved by this suggestion was attractive enough for us to agree to move Stands 13 and 14 as long as they were moved far anough so that the new foundations could be installed complete and ready for the equipment without at that time disturbing the existing foundations and equipment thereon.

This required a move of about twelve feet instead of five, and it was then determined that we might as well make the move nineteen feet which would then allow the use of another existing design of three-strand repeater between Stands 12 and 13, thus eliminating additional items of engineering and pattern making.

This left the cross conveyor as a major item to be designed from scratch. Moreover, it was also the item we were going to need first. It appeared that the least possible interruption to production would require at least two separate shutdowns for equipment installation. Installation of the cross conveyor as part of the first shutdown would allow us to discontinue using conveyors 2 and 3 so that on restarting after the shutdown the mill could continue to operate as a two-strand mill, but with the rod coils from all four pouring reels being handled by the two outside conveyors as previously described. This would then allow the work of shortening the two center conveyors and installing the two new reels to proceed while the mill was operating.

A plant shutdown for a two-week vacation was scheduled for August 1951 and if the cross conveyor could be ready for installation then, no production loss would be entailed in accomplishing this first step.

However, this was only seven months away and our supplier was too heavily loaded with previous commitments to undertake the necessary engineering and manufacturing of the cross conveyor in the limited time available. Arrangements were therefore worked out to send four of our own draftsmen to the supplier's plant to assist in getting out the necessary drawings, and for our own construction shops to take on the making of patterns and the manufacture of the conveyor parts.

We also undertook the manufacture of the billet switch, toggle shear and all the new guide equipment from drawings to be furnished by our supplier while he concentrated on the flying shear, repeaters, switches, snap shears, and pouring reels. In this way, all of the equipment could be available for installation early in 1952.

CONVEYOR COOLING

In the meantime, we had turned our attention to providing some means for greatly increased cooling on the two outside muffle conveyors to be ready when the new cross conveyor was installed. Past experience showed that the cooling was just barely sufficient, particularly on the bigger sizes of rods, when each reel had its own conveyor. With the new arrangement planned, each outside conveyor would handle the coils from two reels instead of one, which meant not only twice as much tonnage through the conveyor, but each coil would be in the conveyor tunnel only half as long.

The two center conveyors, while only handling the product from one reel as before, were to be reduced from the existing 110 feet to only 30 feet of cooling length.

This additional cooling was obtained by installing a belt-driven duct type exhaust fan on each conveyor as shown in Figure 3. The fan intake hood replaced one of the water cooled covers of the muffle conveyor, and it operated to pull a stream of air over the coils from each open end of the conveyor tunnel. The location was chosen closer to the hot end of the conveyor so that the volume of air pulled over these hottest coils would be sufficient to keep the temperature rise of the air within safe limits for the fan bearings. To further protect the fan bearings, three interconnected dampers in the fan intake hood automatically cut off connections to the conveyor and admit room air into the hood in the event the fan is not running, or stops for any reason.

It was impossible to arrange to run the fan discharge duct to the outside of the building because of building crane interference so the discharge duct was stopped short of the crane bridge clearance line, and a second fan of twice the capacity was installed directly above, over an opening cut in the roof. This has proved successful and not only gathers up the hot air discharged from the fan on the conveyor, but contributes measurably to general mill ventilation as well.

The capacity of the fans on conveyors 1 and 4 is 30,000 cfm each and the roof fans above them are 60,000 cfm each. On the short center conveyors, the fan capacity is 60,000 cfm each and in this case there is no interference from the crane and the discharge duct goes right on up through the roof.

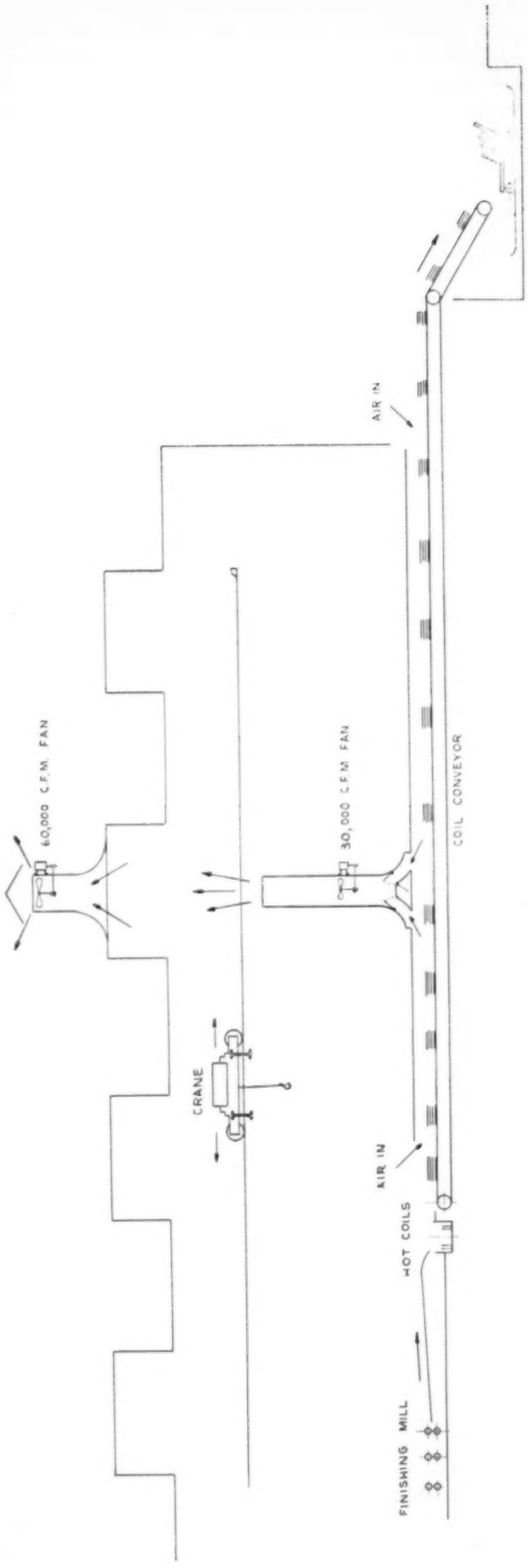
This arrangement not only delivered coils cooler than before, but gave us an unexpected benefit in that the percentage scale loss on the rods was reduced from 0.74 to 0.55 per cent by weight and this saving alone more than returned the entire cost of the fan installation in the first year of operation.

BILLET SWITCH

Among other items of equipment involved in this change-over to three-stranding is the three-strand billet switch between the heating furnace and Stand 1. It is of conventional design and its function is to guide a billet as it is pushed out of the furnace into any one of the three pass lines in use in the mill while at the same time lifting the billets that are already being rolled, out of the way of the incoming billet. The lateral movement of the switch plate is obtained from a hydraulic cylinder with three sets of exhaust ports in the cylinder liner, each provided with a solenoid operated valve which the operator controls by pushbutton.

The switch operator has four pushbuttons, one for each of the three pass lines, and one to raise the switch plate when he is ready to feed a billet into the mill. As soon as the billet starts into the mill, he pushes his next

Figure 3 — Additional cooling was obtained by installing an exhaust fan on each conveyor.



pass line selection button and the switch plate first lowers and then moves to the selected pass line and stays there until he raises it again. Interlocks prevent table traverse except when lowered.

Raising and lowering of the switch table is by means of a solenoid valve controlled air cylinder acting through an arrangement of crosshead, connecting rod and bell crank.

Hydraulic power for lateral traverse is supplied from a 12-gpm pressure controlled variable volume pump driven by a 10-hp motor. The pump pressure is maintained at 700 psi but this is reduced to 350 psi for the switch operation. The 700 psi oil is used for traversing the flying shear on its base to the right position when new passes are taken at Stand No. 8. The 350 psi oil is connected through a pilot direction valve to both ends of the traversing cylinder with the three sets of exhaust ports. Opening any one of the exhaust port valves by pushbutton unbalances the pressure on each side of the piston and the piston traverses until it reaches and covers the port that was opened. This balances the pressure on each side of the piston again, and it remains "locked-up" at this position until some other exhaust valve is opened.

FLYING SHEAR

A new 12-in. steam operated flying shear used to crop the front ends after Stand 8 was needed because the old shear did not have enough lateral knife movement to cover three pass lines instead of two. The top knife is moved manually to select the line to be cut, and the shear may be tripped manually, or automatically by flag switches in each pass line at Stand 4. The flag switches actuate a timer which, in turn, operates a solenoid to trip the shear. As mentioned previously the whole shear is traversed on its bedplate by a hydraulic cylinder when changing pass lines in the roughing mill.

MISCELLANEOUS ITEMS

New rest bars and guide boxes were installed throughout the mill. In most instances no change was made in the guides themselves. Roller twist guides are used in the roughing mill on the delivery side of Stands 2, 5, and 7 and these were redesigned to use anti-friction bearings instead of the bronze bushed bearings previously used.

When the mill is operated as a two-strand mill as it still is on flats and all rods above 0.250 in. diameter, it is necessary to take care of equally distributing the wear between the three pass lines in Stands 1 through 14 by rolling a certain number of billets on the center and outside pass, and then the same number on the center and inside pass, and finally the same number on the outside and inside pass.

When two-stranding, only one pass line is used in each finishing mill, and the rods are switched from reel to reel after they leave the finishing stand. These switches are operated by water bucket just as they were when the mill was installed. However, the manually operated lever valves for control of the water have been removed from the reel operator's pulpit and he now controls remotely located solenoid water valves from pushbuttons on his control desk.

It might be noted here that since the two new reels are located some 75 feet from the pulpit, and more or less behind the operator, three mirrors are being successfully used to bring these reels into his normal line of vision, with two of the mirrors near the reels set high on the motor room wall so he can see down into each of the reels.

When the mill was operating as a two-strand mill with only one pass line in use in each finishing mill, the spacing of holes on the rolls was not too important as long as each pair in any one stand matched one another. Variations in depth of adjacent holes could be easily taken care of. With three-stranding where each guide box holds three pairs of guides on exactly 4¼ in. centers, it became necessary to hold the pass centers exactly and, even more important, to hold the depth the same on all three holes that are used at the same time. Gang tools with tungsten carbide inserts were developed which successfully produced the accuracy required.

The new reels, motor-generator sets, electrical controls and wiring, etc., were installed without interrupting production on the mill and on Memorial Day weekend in 1952 when the mill was scheduled for a shutdown over Friday, Saturday, and Sunday, we moved in and installed the new billet switch and flying shear. Then a steel strike was called on Monday, June 2, which was the day the mill started up again and the strike was not settled until August 1.

When the plant returned to work, there was no longer any two-week scheduled vacation available that we could use to finish up the installation job and so we were under pressure to undertake to do the job in one week instead of two as we had counted on.

By doing some portions of the work on several successive Sundays, we finally moved in again at midnight Saturday, September 13, and the mill was ready to roll three strands eight days later at midnight on Sunday, September 21, 1952.

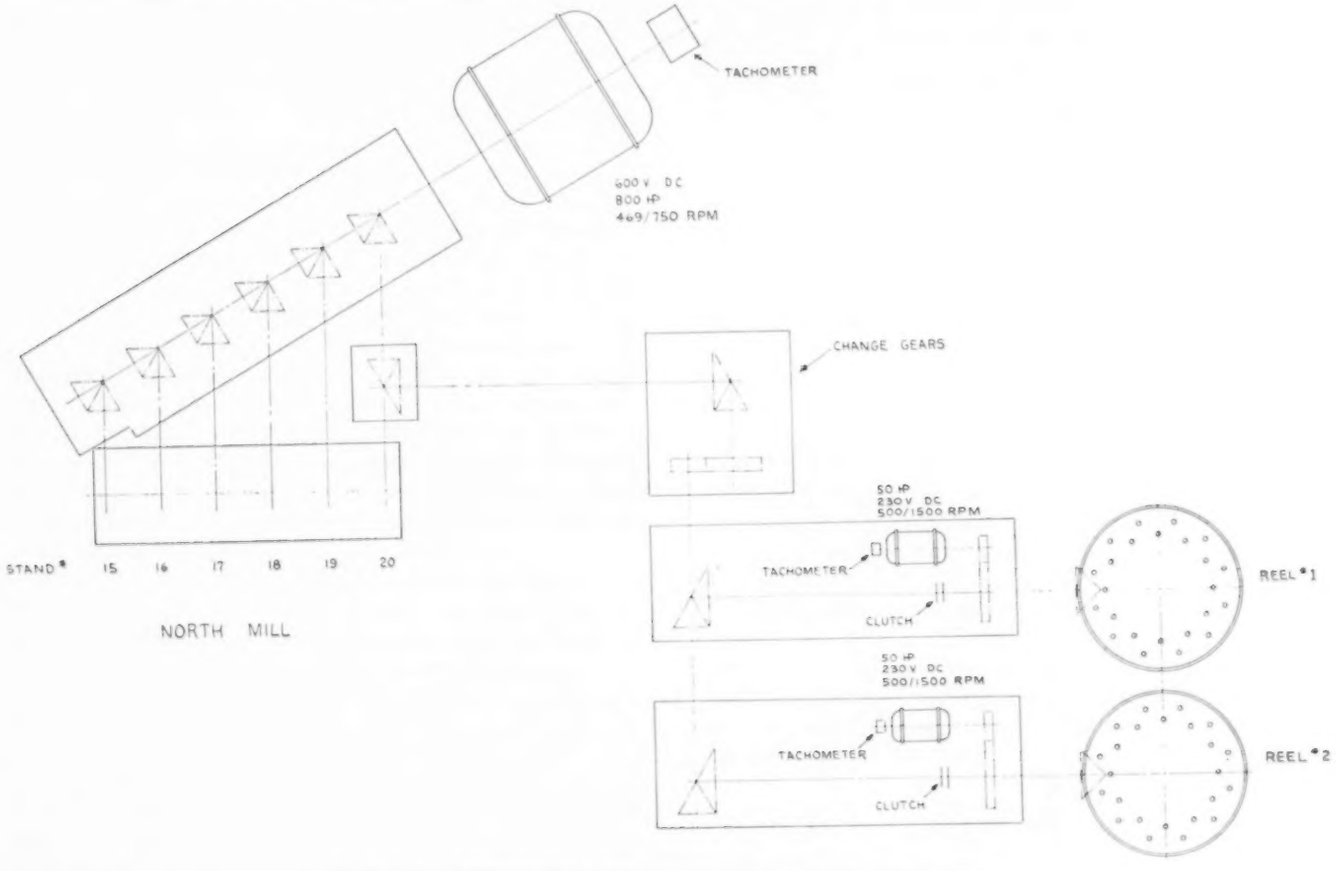


Figure 4 — Original reel drive was through gears and shafts.

INSTALLATION

The actual installation of the various items of equipment was accomplished about as planned. The cross conveyor was ready in time for the vacation shutdown in August 1951 and our construction forces worked around the clock installing it, together with the cooling fans on conveyors 1 and 4, shortening conveyors 2 and 3, pouring the new foundations for Stands 13 and 14, and parts of the foundation where the new reels were later to go.

After vacation, the mill resumed two-strand operations with only the two conveyors in use instead of four.

The number and type of changes made to the mill meant that as far as the mill operators were concerned, they were almost starting up a new mill and therefore we had to go through a breaking-in period during which time our production supervisors were not only considerate of our problems, but very helpful as well, and the mill was soon rolling at the anticipated tonnage level.

The quality of the rods was given much consideration before starting this project, and we were aware of the fact that it would be more difficult to maintain as accurate roll settings in the finishing mills when rolling alternately one, then two rods; it was felt that this could be accomplished without too much sacrifice of

rod quality, at least enabling us to meet normal hot rolled rod specifications.

Although rods rolled at the start of the three-strand rolling were inclined to be more "out of round" than previously, the condition has been gradually corrected and our later inspection reports indicate that the rod quality is good and that rejects are at a very low level.

The actual loads on the mill motors have proved to be well within their ratings as anticipated, and no trouble with the mill drive gearing has been experienced, with one exception mentioned later. Any increased wear of the gears has not been sufficient to be apparent at the periodic inspections that have been made since the mill has been three-stranding.

REEL DRIVE AND CONTROL

The original drive for the reels was accomplished by gearing and shafting as shown diagrammatically in Figure 4. A set of bevel gears was driven by the shaft driving No. 20 stand and that drive was coupled to the two reels used for reeling the rods finished in that finishing mill.

The motor was used to start the reel and as the reel came up to synchronous speed, a relay compared the output voltage of the tachometers on the reel motor and the mill motor, and when these voltages balanced, the clutch circuit was energized and the reel motor circuit was opened allowing the motor to be rotated idle during the reeling time. When the rod was completely reeled, the operator, by master switch operation, opened the clutch circuit and applied dynamic braking to the reel motor thus bringing the reel to rest after which it was stripped and made ready for restarting.

This plan had given good service during the life of the mill, but was limited as has been mentioned previously, by the limitations of the change gears and therefore acted to restrict the roll diameters that could be used.

Another objection to this plan was that the relatively high WK^2 of the rotating mass of the reels and motors was a source of severe stresses set up in the gearing whenever a change in speed was made in the finishing mill. These changes were quite frequent, and although of a small percentage of the operating speed, they did result in severe shock loading of the bevel gear set at stand No. 20 drive shaft and caused a failure of one of these gears.

This fact coupled with the need for arranging the drive for the new reels to be installed led us to consider an alternate drive for all of the reels. Our investigation led us to the conclusion that a variable voltage generator large enough to drive two of the reels, and at the same time accelerate the third reel connected to each finishing mill, would do the job in a satisfactory manner. A rotating regulator was installed on each generator to regulate the generator voltage to match the speed of the finishing mill. Individual reel speeds could then be corrected by varying the shunt field current of their respective motors and in this way complete synchronization be maintained for any given set of conditions, whether finishing from stand No. 20 or any other stand in the finishing mill, and without regard for the diameter of the rolls being used.

To assist the pulpit operator in setting the reels to their proper speeds, an indicating tachometer was mounted in the reel control pulpit for each reel and for each finishing mill and instructions were given for the reel speed settings for various mill conditions. These settings were approximations that brought the reels in to close synchronization, but the final trimming at the start of rolling any given size or from any stand is made by the operator from visual observation as the rod is reeled.

The schematic diagram of this reel drive is shown in Figure 5. Here we can see how the output of the mill motor tachometer generator is used to control the regulator circuit to match output voltage to any given speed of the mill motor.

From this it is seen that whenever the speed of the mill motor is changed, a proportional change is made in the voltage applied to the reel motors and as motor speed is directly proportional to armature volts, when no change is made in the field strength, the reel motors are held in close speed control. The length of cables between the reel motors and the generator is quite short and response has been rapid enough to justify our decision to not install any automatic IR drop compensation.

It is also seen that each generator is brought up to operating voltage as soon as the control on any one of the three reel motors is started and the voltage maintained until all three of the motors are stopped. This is accomplished by using the interlocks on all three reel motor controllers in series with the anti-hunt field connection causing this field to act as a suicide field.

The size of the generator finally selected was a 75-kw at 230 volts each driven by a 150-hp induction motor and having directly connected a 10-kw, 230-volt exciter which supplies field current and control current for the reel motors. The connected load to each generator is two 50-hp, 500/1500 rpm motors each driving one of the original reels and one 35-hp 575/1725-rpm motor driving one of the new reels. Careful studies of the motor loads during reeling time and of the motor loads during acceleration time led us to the conclusion that the generators would be of ample size to handle the load and this has proven to be correct in actual operation.

The increase of two reels to the existing reel group made it necessary for us to look into the possibility of reducing the actual operations to be performed by the pulpit operator and convert his work assignment to one which would consist more of observation rather than one of actually manipulating control master switches.

The reels connected to either finishing mill are started by the operator prior to a rod being entered in the mill. When the rod has passed through the mill on either of the passes being used through a switch position previously selected, it automatically establishes a circuit which causes the respective rod switch to try to move to the alternate position, but it is restrained from doing so by the rod being rolled.

As soon as the last end of the rod passes the rod switch, the switch moves to the opposite side of its travel and operates a limit switch which stops the reel after enough time has been allowed to complete the reeling of the rod.

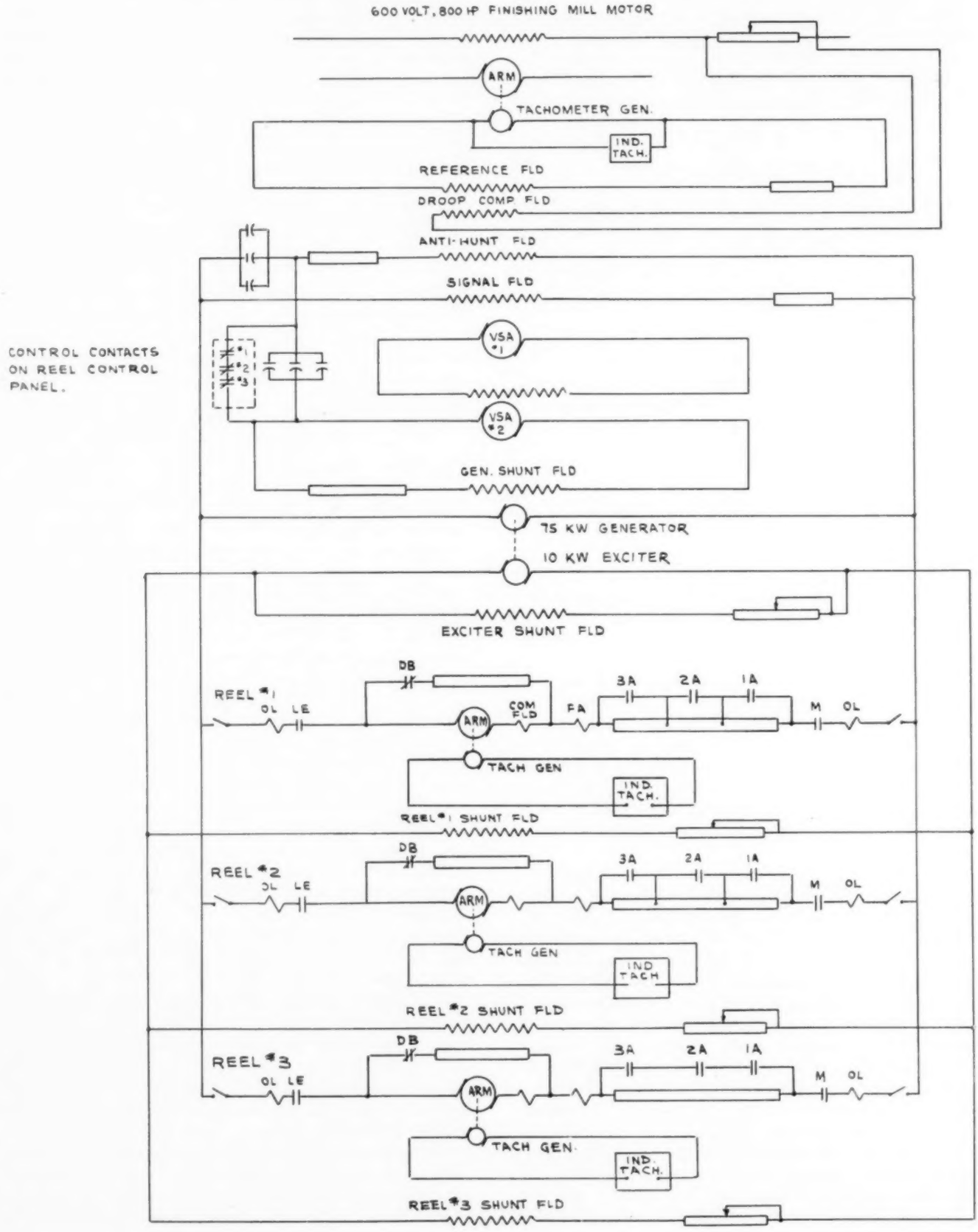
As soon as the necessary time has elapsed, the reel is shut down and when it has come to a stop, the circuit controlling the stripper is energized and the stripper raises the reel plate and pushes the coil from it to the

conveyor. At the time the pusher is at its extreme stroke, the conveyor is started, by a contact of a rotating limit switch on the stripper, and moves forward one position, thus leaving a space for the delivery of the next coil and the stripper completes its cycle.

At the completion of the cycle, the stripper is stopped by use of other contacts in the rotating limit switch and the reel is started by a timer, thus made ready to receive the next rod to be rolled in the connected pass.

The conveyor, meanwhile, has moved the desired

Figure 5 — Schematic diagram illustrates reel drive speed control.



distance and is also stopped by a limit switch operation.

These functions of the reel, stripper and conveyor are all interlocked so that the reel cannot be started until the stripper has completed its cycle and the conveyor moved far enough to prevent tangling of the coil last stripped.

It must be remembered that as two reels are used to alternately reel the rods delivered from each pass, the reel being stripped must come to a stop, have the coil pushed off, the conveyor started and the reel restarted and accelerated to synchronous speed during the short time required for the other reel to wind up the rod being rolled.

made necessary the design of a cross conveyor which would receive the rods reeled on reels No. 2 and No. 3 respectively and deliver them to conveyors No. 1 and No. 4 as part of the plan called for the cutting off of conveyors No. 2 and No. 3 in order to provide space for the new reels.

The general plan of this conveyor assembly is shown in Figure 6.

This conveyor consists of a cast base with a chain in the center that is driven by a motor with suitable gears coupled to a drive sprocket at each end of the conveyor. This plan was used in order to always have the conveyor "go devil" being pulled in the direction it was to

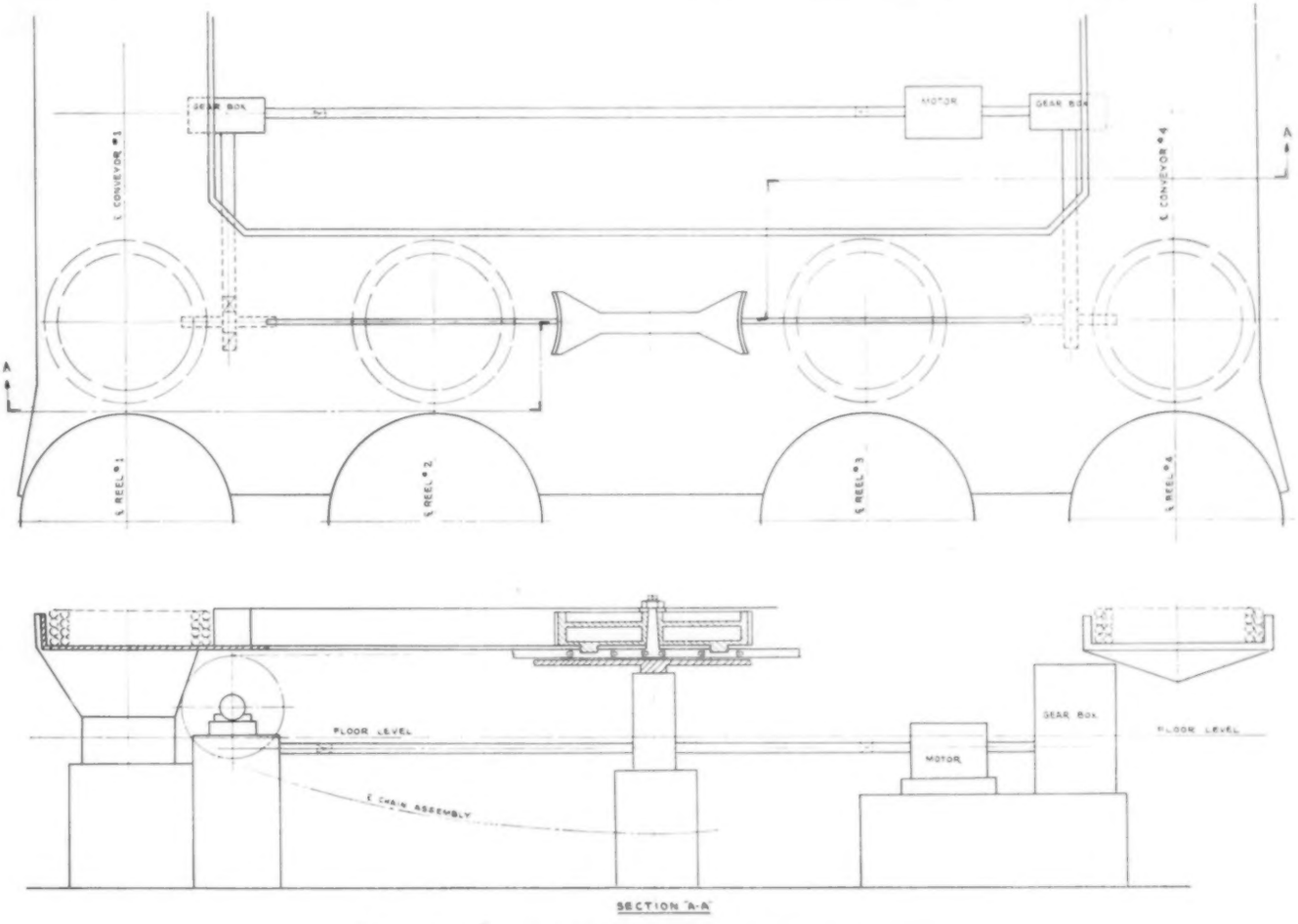


Figure 6 — General plan shows cross transfer conveyor.

As this mill requires between 40 and 60 seconds to roll a rod, depending on the size being rolled, it can be seen that the operations of this equipment must be carefully timed and regularly performed. The equipment is operated under this severe condition as each reel must complete the cycle outlined above at least 30 times per hour and in some cases up to 45 times per hour.

In face of this severe service, the reels have performed as planned and have been operating with little or no trouble since the mill was converted one and one-half years ago.

CROSS CONVEYOR

The decision to install two additional reels in the mill in order to achieve the increased mill production

travel and to allow all chain slack to accumulate below the base where it would not interfere with normal operations.

The schematic wiring diagram for this control is shown in Figure 7, and it will show how the operation is accomplished with the safety precautions that were necessary to prevent tangles and resulting mill delays.

After stripping reel No. 2, the control method automatically starts the cross conveyor to moving the coil delivered by No. 2 reel, to No. 1 conveyor, and as it deposits the coil on No. 1 conveyor, the conveyor is interlocked so that it starts and moves ahead one space and the cross conveyor returns to the center and stops. All stripping of No. 1 reel and movement of No. 1 conveyor is delayed when the cross conveyor is moving in the direction of No. 1 conveyor, but a control circuit initiates this delayed stripping as soon as the cross

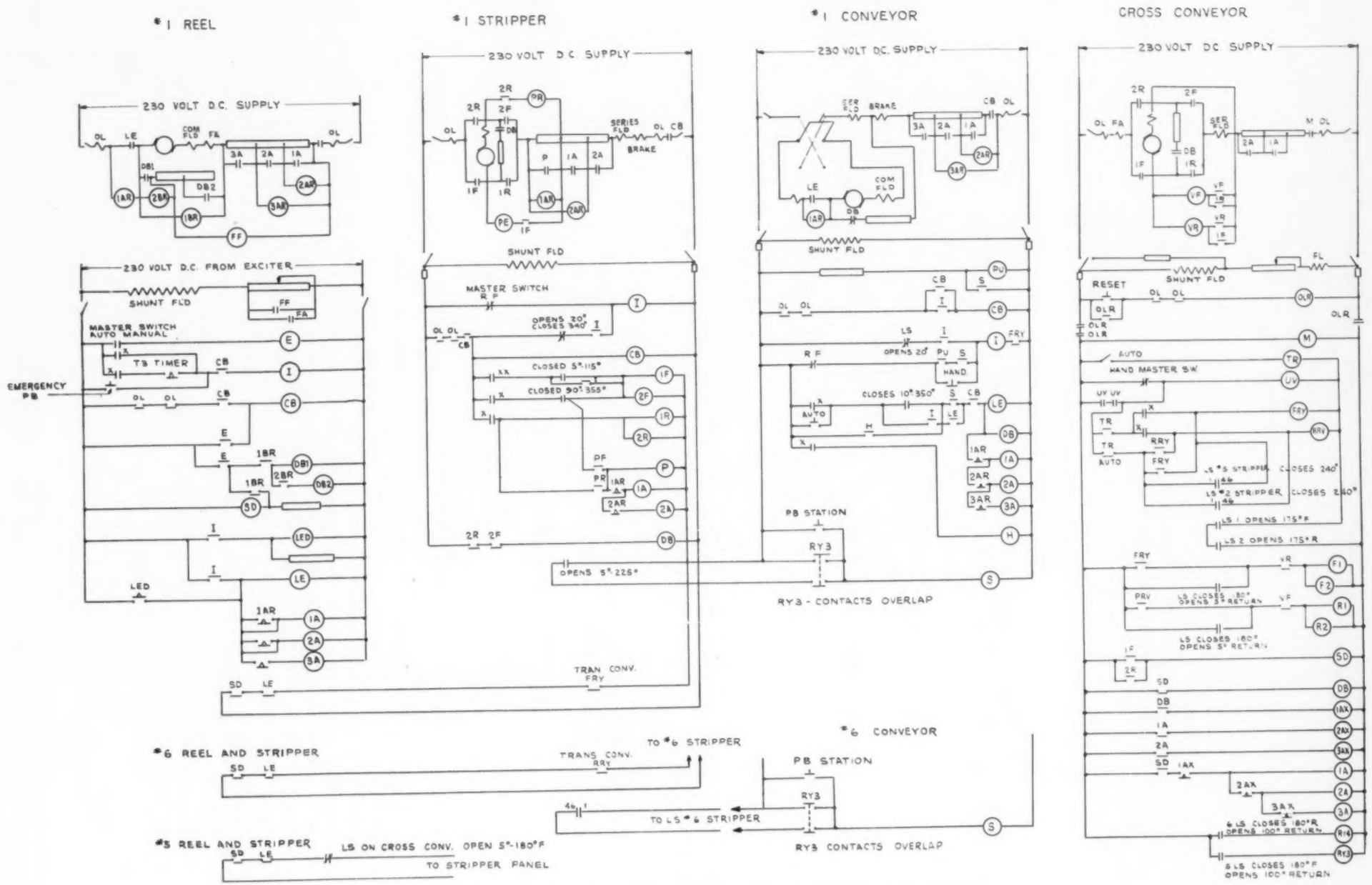


Figure 7 — Schematic shows wiring diagram for reel, stripper and conveyor.

conveyor has started on its return stroke, and the No. 1 conveyor has moved ahead to provide space for the coil to be delivered by No. 1 reel.

In a similar manner, the operation of the cross conveyor is delayed and a circuit energized if the No. 1 reel is in the process of being stripped when the cross conveyor is normally expected to start. This circuit starts the cross conveyor as soon as the No. 1 reel stripper has completed its operation and the conveyor has moved ahead to provide the space for the coil being delivered by the cross conveyor from No. 2 reel.

The same interlocking plan is used when No. 3 reel is being stripped and the coil from it is being moved to No. 4 conveyor.

ROD SWITCHING

The operation of this mill made a system of automatic rod switching almost a necessity so the alterations were planned to include this improvement.

The actual operation of the several rod switches is accomplished by a pneumatic cylinder connected to the rod switch, operated from the mill compressed air supply and controlled by a solenoid valve. The several solenoid valves and relays were mounted in a bank in the motor room and lines run from there to each of the valve positions.

At the start of a run, the switches are positioned by the operator and after the rod starts through the pass and reaches the reel, the switch control is energized admitting air to the cylinder causing it to attempt to move the switch to the opposite position, but the switch is restrained from moving by the rod being rolled. As soon as the rod end passes, the switch moves over to the opposite position. This movement of the switch energizes a timing relay which stops the reel after sufficient time has elasped to allow the reeling to be completed and initiates the stripping action.

The motion of the rod switch also sets up a circuit for the return stroke and actuates a signalling control which is installed to keep the mill operators informed of the switch position at all times.

DISCUSSION

PRESENTED BY

ROGER KINNICUTT, JR., Rolling Mill Engineer, Morgan Construction Co., Worcester, Mass.

J. C. SEIBERT, Superintendent Rod and Wire Mill, Bethlehem Steel Co., Johnstown, Pa.

W. W. HOFMANN, Assistant Chief Engineer, Bethlehem Steel Co., Johnstown, Pa.

LOUIS MOSES, Mill Engineer, Bethlehem Steel Co., Bethlehem, Pa.

ROSS E. BEYNON, Consulting Engineer, 7658 Coles St., Chicago, Ill.

A. W. STRACHAN, Division Superintendent Rod Mills, American Steel and Wire Div., United States Steel Corp., Donora, Pa.

W. E. ZELLEY, Divisional Plant Engineer, John A. Roebling's Sons Corp., Trenton, N. J.

C. H. BURDEN, Chief Project Engineer, John A. Roebling's Sons Corp., Trenton, N. J.

Roger Kinnicutt, Jr.: These comments probably do not add a thing to the paper, but have to do with a problem very often encountered when undertaking a conversion of an increase in the number of bars without adding reels to certain mills. This opens up a subject which is increasingly becoming a problem in mill layout and design; namely the handling of billets to the mill, and the handling of the finished product from the finishing stands. With mill delivery speeds continually on the increase, and with three and even four strands rapidly becoming standard practice, the coiling of rod and the handling of rod coils must be minutely studied for each installation.

The problem revolves, of course, around the reel cycle. With the number of reels too few for a given situation, during a given period of time, that portion of the period available for stripping the coil from the reel becomes very small relative to the portion of time for coiling. Proper coil conveyor design and coordination can permit this relationship. At times larger billets, and thus heavier coils are the answer, resulting in the same relative cycle time elements, but providing at least the minimum time required for mechanically moving the coil from the reel to the conveyor and readying the reel for the next front end plus maximum possible delay time caused by conveyor-reel relationship at the instant the coil is ready to move from one to the other.

The problem has then three possible solutions, or a solution combining one or more of the three: (1) heavier coils, (2) more reels, (3) high capacity carefully coordinated conveyor system. The first could require a longer reheating furnace or additional roll stands or rebuilt drives or all three. The second could require costly rearrangement, new buildings, etc., due to space limitation for practical additions of more reels, the third, though practical and sometimes needing the least capital expenditure, usually will impose the necessity for timing the feeding of the mill to avoid tie-up at the reels.

At Roebling, the primary choice was No. 2 with No. 3 employed as a refinement. It would have been possible though not too practical to arrange two additional reels such that they could discharge coils onto the existing conveyor system.

The final arrangement, as shown on Figure 2, resulted from the combined thoughts of J. A. Roebling's and our company.

I would like to add that without the competent engineering staff at Roebling's and their careful and intelligent planning this job would have been very difficult of accomplishment according to the schedule laid out, even had we been able to concentrate our entire force on this one job.

J. C. Seibert: This layout is different from what we have in our mill which has only one set of finishing stands and we roll three strands in four lines. I would like to raise the question whether the long distance from the finishing stand to the reel had any effect in reeling.

W. W. Hofmann: What delivery speeds are we talking about on this mill at present? Has there been

any change from the 4000 fpm originally set up? I assume that there is not and that your increase in production is attained purely through three-stranding.

The cooling methods employed on the muffle conveyors are very interesting to us since we may in the future have need to consider something similar. Apparently you are getting good efficiency in cooling and your reported reduction in scale loss of approximately 0.20 per cent is certainly an attractive saving.

Louis Moses: Mr. Zelley and Mr. Burden have admirably described Roebling's solution to the problem currently confronting every plant concerning rearrangements of mills to obtain an augmented tonnage rate without, at the same time, risking any diminution of the quality of the rolled products. In fact, any changes must incorporate means to improve surface excellence and quality generally so far as rolling practice can do so in combination with the metallurgical advances. The aspects of practices and quality are inseparable. The authors have clearly described the change-over to accomplish such objectives.

Each rod mill presents its own particular problems, but certain factors are more or less common to all of them when altering from a two-stranding operation to three-stranding. I would like to ask several questions in this connection.

The first concerns variable gages produced during the day when the inevitable one, two or three strand rolling intermittently occurs, this affecting roll-separation pressures. It would appear that such conditions would have lessened effect on the Roebling mill with its dual finishing-stands than on other fully tandem-arranged stands when all three strands are in the finishing rolls. Any gage variations at Roebling would thus be largely attributable to roll pressure variables in the roughing or intermediate stands. Roebling thus would have an advantage over tandem mills which have had to battle such a condition. What is Roebling's experience?

Have operations proceeded to the point where the added strand has produced a 50 per cent increase in the tonnage rate over the former two-stranding operation? It is recalled that one mill having gone to three-stranding some years ago was dubious that its former rate of 22 tons per hour would be increased to 33 tons. However, it soon did so after the "bugs" were worked out and, along with a slight change in finishing roll diameter, now regularly produces about 37 tons per hour of $\frac{7}{32}$-in. rods.

Was the finishing speed changed?

It is assumed that the use of 2 inch, 400-lb billets is continued? Why does Roebling roll No. 6 rod in contrast to the otherwise almost universal practice of the industry of producing $\frac{7}{32}$ in.?

As related to Mr. Seibert's question, would the authors comment on their experience with the long conveyor pipe serving the new pouring reels and what, if any, difficulties are had with back-end pull? It would also be enlightening to know about the water-cooling in the pipes.

Does the author's reference to carbide inserts extend to mill guides? Sintered titanium inserts are being tried on some mills with astonishing results in avoidance of scratching. Does Roebling have any experience with carbide materials in twist-guides where guide scratching proclivities are even greater than in the thus far tried entering guides?

Ross E. Beynon: Listening to this explanation of the Roebling rod mill there is one question that occurs to my mind, that is, why roll $\frac{3}{16}$-in. rod when most mills stop with the No. 5 rod?

Roger Kinnicutt, Jr.: Mr. Zelley touched on the various studies made of product mix and furnace capacity to determine what output gain was required, what output gain could be achieved, and how quality would be affected. He also mentioned the careful examination of power and drive capacities which were found to be capable of handling the desired increased tonnage. Such studies are, of course, absolutely necessary but are by no means the whole story.

The big question is not "Can more steel be rolled?" but "How is more steel to be put through the mill?" Possible solutions were to retain present rolling practice with an increase in speed which in this case for the required 30 to 40 per cent gain would result in maximum delivery speeds out of No. 20 stand of 5280 to 5600 fpm; to add a third strand with no increase of rolling speeds; to enter a larger billet to increase yield and efficiency; or a combination of these methods?

If the first method were chosen it possibly could be accomplished by installing new main motors or new gear ratios or both at the finishing end of the mill provided that the reels could coil the rod at the increased speed and, if so, that the reel cycle would handle the increased number of coils per time unit, and further that the conveyors could carry away the increased number of coils per time unit. If available reels were not capable of the higher coiling speeds, then would all new reels plus mill drive changes require less capital expenditure than the additional reels, guide equipment, etc., necessary if the second method were chosen? Would the larger billet aid either method chosen provided existing billet mill facilities could economically product it and existing finishing facilities handle a heavier rod coil?

These and many other questions must be evaluated before deciding on the means of increasing the output of any mill. The physical arrangement of the particular mill, the available space for new equipment, the condition of existing electrical and mechanical components, and the capital expenditure that can be justified, all further complicate the basic questions and introduce problems peculiar to the mill being studied.

For the mill which we have just heard about, the type of existing reel could tolerate no speed increase and so a third strand seemed to be indicated. The question then was: Could the existing four reels then handle three strands and, if so, how to feed the strands to the reels? Could four pass lines be employed throughout the mill which would then operate at 75 per cent full groove? Careful timing and close coordination of the conveyor system with the reel cycle might possibly have permitted four reels to handle the increased number of coils but would have provided too many opportunities for delay. Also in this case the existing roll face in the roughing mill would cause uneconomical pass distribution were four active passes employed. The split finishing train introduced too great a complication to allow the devel-

opment of a reel delivery pipe setup capable of handling three pass lines.

A. W. Strachan: I just wondered if there was any difficulty in reeling the rods at the distance you described there, and do you roll these rods three lines?

W. E. Zelley: Our discussion will be general in nature and will not be addressed to individuals, answering specific questions asked by them, as the answers to several questions have a definite bearing on the answer to other questions asked by the members.

The question of finished rod size is receiving considerable attention from our people as we realize that practically all other rod mills are rolling a 0.218 or 0.250-in. diam rod as their minimum size instead of the No. 6 rod, 0.187-in. diam, that we roll.

Many of our manufacturing processes were set up some years ago based on using the 0.187-in. rods and a change to larger rods would mean a complete revision of those practices and the making of high quality products does not readily lend itself to changes of that sort.

We are, however, working toward the use of the larger sizes of rods and the future may see the change completed and the small rod size eliminated.

C H. Burden: The question was asked whether we have had any difficulties due to the distance from the finishing mills to the new reels. The old reels are about 30 feet from the finishing stand while the two new reels are about 115 feet. That feature caused a tremendous amount of concern when first suggested. However, on the basis of experimentation that was carried out before this project was started, we concluded that the only reason for having difficulty in delivering the rod through 115 feet of pipe was the resistance of the cooling water in the pipe, and it was therefore thought that if we could arrange to shoot the cooling water down the pipe at a speed equal to the speed of the rod, or preferably a little faster, the water would help to get the rod down the pipe, and we proceeded on that basis. We designed and arranged annular-shaped nozzles at various locations along the pipe, pointing in the direction toward the reel, and supplied them with water at 120-psi pressure. The annular orifices were adjusted so that the velocity of the water in the pipe was about 70 fps, and since our finishing speed on the rod is about 66 fps, we expected that the water would materially assist in getting the rod down to the reel. When we started the mill, we had absolutely no trouble with the rod going down to the new reels, and have since found that the rather elaborate nozzles and the high water pressures are not entirely necessary. We have on occasion shut down the booster pumps supplying the high water pressure, and used mill water at 20 psi or so, which does not produce water velocity anything like the velocity of the rod, and the rod still goes down successfully. We have even on occasion shot some flats down there and they usually give trouble in reeling because we roll thin flats with hardly any stiffness in them.

One thing that we did not realize until we actually saw it was that the problem on the long delivery pipes seems to be only one of shooting the front end of the rod down to the reel. Once it gets started on the reel the centrifugal force acting on the rod as it curves around from the delivery end of the pipe onto the reel pins actually puts the rod under tension from then on. We did not foresee that and when we started to operate we were baffled by the fact that we made a beautiful coil until the last end left the finishing mill and then the rod would fly out against the outside pins with enough force to actually buckle the rod into scallops between pins. We had expected that when the back end left the finishing mill we might have trouble making the reel pull this section of rod through the delivery pipe. We expected it would be pulled against the inside pins instead of piling up against the outside pins.

We are only three-stranding three sizes: the 0.187, 0.218 and 0.250 in., and those are the only rod sizes that we deliver down these long pipes.

Practically all of the rods we roll are high carbon with the majority running anywhere from 0.30 to 0.80 or 0.90 per cent carbon and we can three-strand any of the analyses that we run so long as they fall within the three sizes I mentioned. We cannot three-strand anything bigger in size than 0.250-in. because of the limitations of heating capacity and the horsepower of the mill drive motors.

It was asked if we had changed delivery speeds and the answer is no — we made no change at all in the rolling speeds of the mill. Our delivery speed is about 4000 fpm when we are finishing No. 6 rod on Stand No. 20. We have on occasion finished No. 5 rod on Stand No. 20 at a somewhat slower speed, but normally No. 5 rod is finished on Stand No. 18 at 3200 to 3300 fpm.

There has been no change in the billet size: it is 2 × 2 in. × 30 ft giving us a finished coil weight of about 385 pounds.

Mr. Moses asked if we have much trouble with gage variations due to the change in roll separation depending upon whether there are 1 or 2 or 3 bars in the mill. I do not believe we have had as much trouble as we thought we might. There seems to be no trouble through the roughing and intermediate stands. In the finishing mills of course it is a case of either a single rod or two complicated by the fact that the single rod — the outside rod — goes alternately through two different passes. As far as the size change is concerned, it is not too serious although it is measureable. When one rod is running in the finishing mill and the second one comes in, it will change the roll separation and change the size of the rod that is running by something in the order of 0.003 to 0.004 in., but that of course is well within the allowed tolerance.

It would undoubtedly be simpler to have three strands continuously in one finishing mill. Rolling as we do through three holes in two different finishing mills, we have to maintain six sets of guides all through each of the six stands in each finishing mill, and this contributes to the difficulty of keeping everything just exactly right. It is one of the reasons why we cannot consistently obtain the full 50 per cent increase in production that we should theoretically get. Our average is closer to 40 per cent increase over two-strand.

My reference to tungsten carbide applied only to tungsten carbide tools for turning the rolls. We have not yet tried tungsten carbide or titanium carbide inserts for guides, but are setting up to do so and will try it first in the finishing stand receiving guides.

Modern Manufacture and Use of CAST ROLLING MILL ROLLS

By F. H. ALLISON, JR.
Vice President
and
C. E. PETERSON
Sales and Research Metallurgist*
Rolls Division
Blaw-Knox Co.
Pittsburgh, Pa.

. . . science has teamed up with the roll-maker in advancing the art of making rolls . . . .

▲ AT this time, it seems appropriate to review and bring up-to-date the record of the world's most productive metal forming tool — the cast rolling mill roll. Of the 111,350,000 tons of steel ingots produced in this country in 1953, 99½ per cent was formed into usable shape by passing through cast steel and cast iron rolls. Surely, it is worthwhile to periodically examine what is new with such highly important implements to metal production.

PART I — PRODUCTION OF CAST ROLLS

Practically all cast rolls are produced by the bottom pour swirl method shown in Figure 1. Thus, both iron and steel rolls are, in a real sense, centrifugal castings. The circular motion of the metal is induced by fast pouring through a tangential spout. This centrifugal action throws the denser, purer metal to the surface where it is needed. Swirl casting was patented in 1835 and has been in use ever since.

There are two types of molds used for cast rolls. One is the chill type shown in Figure 1 and is used mainly for plain body iron rolls; and, with sand linings, for plain body steel rolls such as backing-up rolls. The mold sections for the top and bottom necks, as well as for the shrink head, are made of foundry sand. The body mold is made of metal which acts as a chiller and condenses the cast roll metal. This minimizes the natural segregation in the case of the steel rolls; and, in the case of iron rolls, produces the chilled hard portion containing a minimum or no graphite. On iron roll necks, the sand mold permits the formation of a softer, tougher roll metal.

At the present time, roll makers are divided between chill molds of two types. Some insist on one piece chillers, even with body lengths 175 in. long; while others claim exceptional advantages for multiple cylindrical chillers built up of sections as small as 3 in. high, as shown in Figure 2. Record breaking rolls have been cast by each method.

The double poured strip mill work roll is made of a hard, wear-resistant shell metal on the working surface of the body; with a second softer, tougher metal forming the center of the roll and the roll necks. The essential

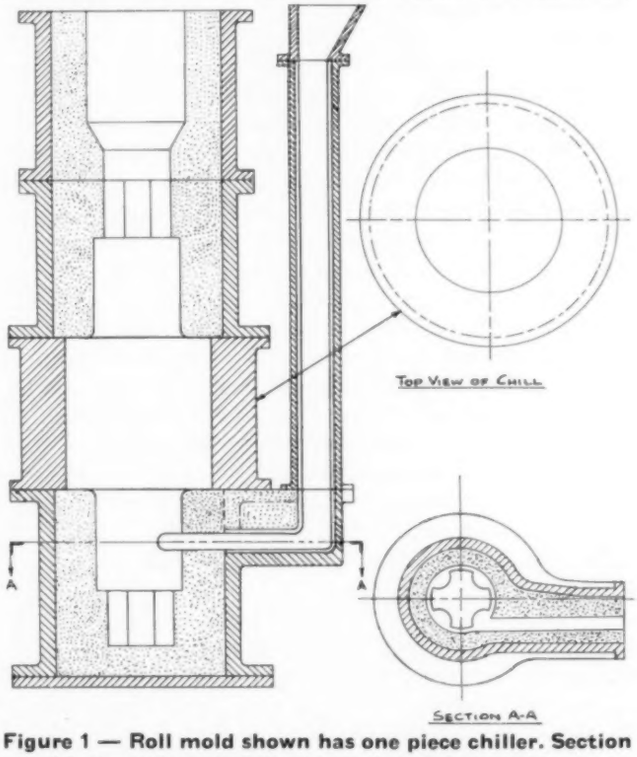


Figure 1 — Roll mold shown has one piece chiller. Section AA shows tangential gate used to induce swirl.

features of all double pouring methods are as follows. The body is first filled with liquid metal of a hard, wear-resistant mix which is allowed to remain in the mold for a pre-determined time. Thus a hard iron shell solidifies in the region of the metal chillers to a depth of 1 to 4 in. depending on the roll size and use. Before the hard metal

*At time of presentation of paper. Now Chief Metallurgist, Mackintosh-Hemphill Co., Pittsburgh, Pa.

Figure 2 — In iron roll casting pit is seen a multiple chiller with plate mill roll mold.

solidifies to any extent on the sand molded necks or in the center portions of the body, it is displaced by pouring a second heat of softer iron through the same bottom gate, while the excess hard metal is drained off through a spout in the top neck, or flows up into the head. Much skill is needed in the production of this type of roll, not only in pouring but also in producing the required shell depth, and in balancing the composition between shell and fill metal for different roll applications. Because of the two separate melts and the extra equipment required, it is more expensive to make double poured than single poured rolls.

The second general type of mold is known as the split flask, as shown in Figure 3. Each half is molded as though the roll were diametrically split through a longitudinal plane, and the two halves are subsequently clamped together for pouring. The molds are made of foundry sand in which metallic chillers are placed where it is necessary to condense the roll metal. This type of molding is most generally used for shape rolls; but it also may be used for plain body steel rolls, such as backing-up rolls. The use of this type can be generally recognized on the rough rolls by the longitudinal seams, apparent at 180 degrees apart around the roll.

The top of the roll casting is the last to solidify and because of this the top or cope neck contains the most segregation. It is, therefore, apt to be weaker than the bottom or drag neck. Thus, there is real merit in designing a roll so that it is driven through the drag neck. In the case of identical necks, many roll makers mark the roll ends with a "C" or "D" so that the user can place the "D" or drag neck in the drive position whenever possible.

There has gradually come into use during the past fifteen years, the practice of placing an electric arc in the head of steel roll molds. This, in effect, creates a small electric furnace at the top of the roll. By providing the necessary heat close to where molten feed metal is required, this method, beside increasing yield in the foundry, materially improves the quality of the cope necks of large steel rolls.

Iron roll metal is melted in reverbatory air furnaces, fired with powdered coal, at temperatures ranging up to 2900 F. Some chill roll metal and, in many cases, the center metal of double poured rolls is melted in the cupola. Metal for cast steel rolls is generally melted in acid open hearth furnaces, capable of higher temperatures up to 3150 F. There has been no major change in the melting equipment during recent years; but considerable improvement in melting practice has resulted from research, in uniformity of melting conditions, slag control, temperature measurements, atmosphere control, and furnace and ladle additions.

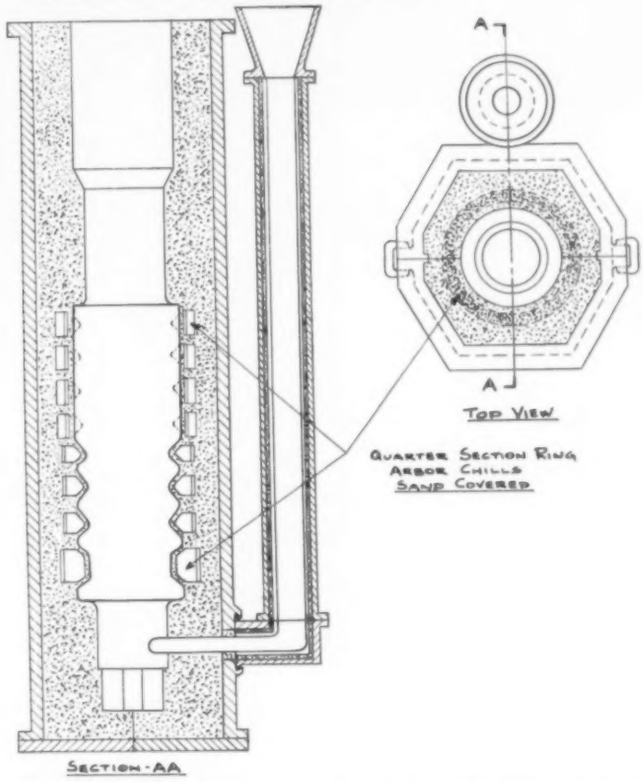


Figure 3 — Split flask roll mold has imbedded metallic chillers.

In the melting of cast iron rolls, it is highly important to charge a substantial percentage of scrap rolls. Iron roll melts made entirely of pig iron and steel scrap, although melted to identical chemical compositions, do not have the same balance between combined carbon and graphite, nor the denseness of surface metal as have melts containing a substantial portion of returned scrap iron rolls. It is, therefore, essential to iron roll quality that the users return at least 40 per cent of their scrapped rolls, preferably of the alloy grain and the plain chill grades. Cast steel rolls present no problem of graphite condition, so the return of steel roll scrap is not critical. In fact, most steel roll foundries are not particularly desirous of remelting scrapped steel rolls, since lower sulphur and phosphorus can be obtained in the acid open hearth from other sources.

The early simple annealing procedures for cast steel

rolls have been supplanted over the last ten years by definite and involved heat treatment schedules with much narrower limits of temperature. Increased requirements for hardness and strength have made it necessary to resort to triple treatments, air cooling and tempering, water spraying, time quenching and other special treatments based on the T-T-T or time-temperature-transformation curves of the particular chemical composition involved.

More recently, a majority of the 4 per cent nickel cast iron rolls are being tempered at temperatures below a red heat, to give longer service life. To better understand the heat treatment conditions of this grade, it was necessary for the roll makers to determine the T-T-T curve. This was a particularly difficult piece of research

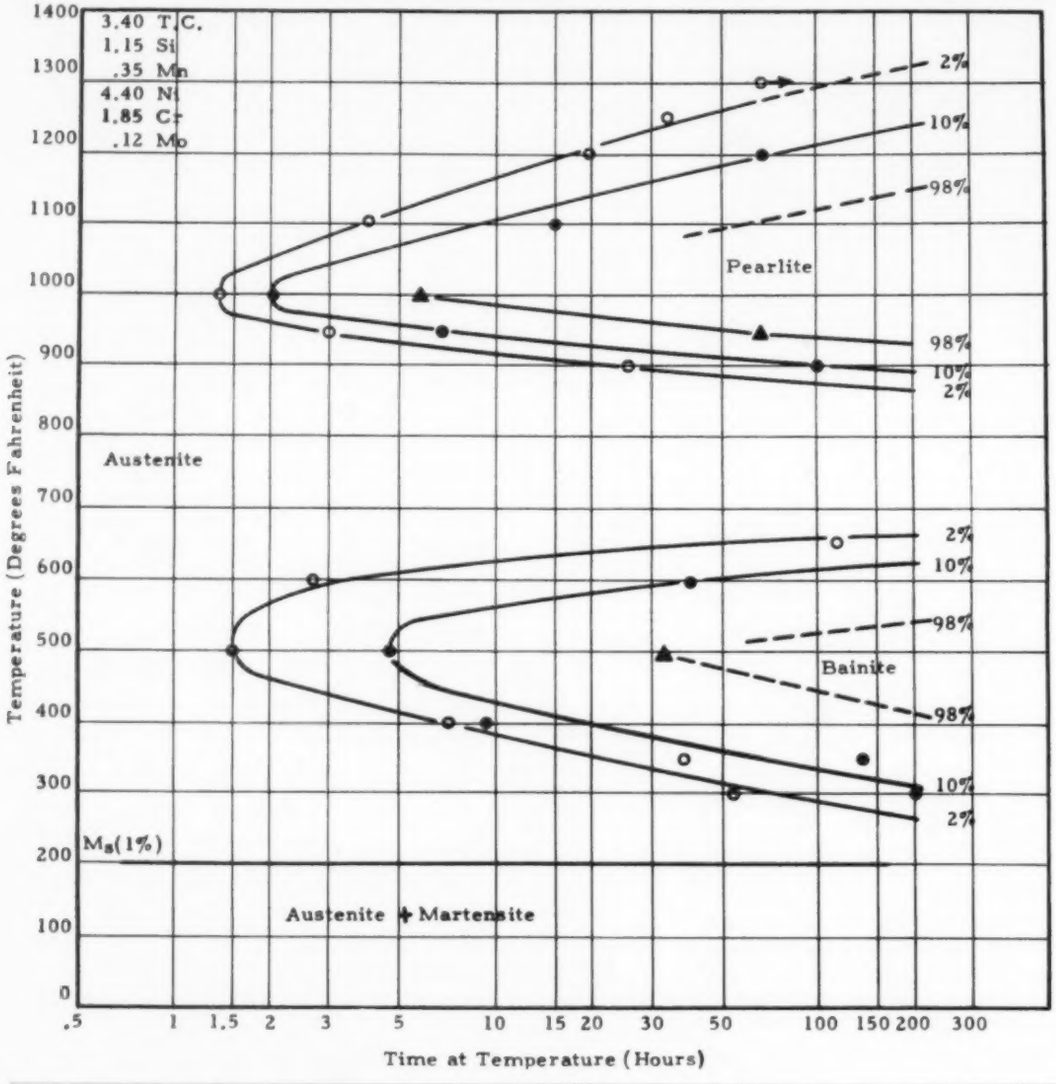


Figure 4 — T-T-T diagram of white alloy iron shows transformation on cooling 4 per cent nickel iron rolls.

and was accomplished only by group effort. The unique feature of this diagram is that the results shown in Figure 4 were determined from solidification temperatures of molten iron. See reference (1) in Bibliography. Due to supersaturation of carbon on cooling from the molten condition, the same results could not be determined from high reheating temperatures as in usual T-T-T curve determinations. In skilled metallurgical hands, this chart is a road map to the hardenability of the 4½ per cent nickel cast iron roll.

Beside developments in heat treatment, there have been cold rolling treatments of steel roll neck fillets, with the object of increasing the tensile strength and inducing compressive stresses which minimize fatigue failures at this critical section of the roll. The process has been applied particularly in backing-up rolls and has every reason to be successful, although fatigue data on such rolls are a matter of many years accumulation and sufficient time has not yet elapsed for completely definite conclusions.

Machining innovations have been the use of engine lathes equipped with carbide tools for cutting hard iron rolls; contour lathes for cutting sections by automatically following a pre-determined templet; the abrasive disc method of removing heads from small rolls; the use of hydraulic or pneumatic feed on plunge cut lathes; and the milling of flat wabblers. The following illustrations were taken from the authors' shops. Figure 5 shows the hydraulic plunge cut tool at work on a hydraulic traverse roll lathe. Figure 6 shows the massive milling machine used to cut parallel flat wabblers. Incidentally, the ever growing use of this flat wabbler design has two distinct advantages over more complicated spline couplings, in that it has not only decreased machining costs but has markedly increased wabbler strength.

The inspection of cast rolls before shipment from the foundry customarily consists of checking for dimensions; visual inspection for surface defects; and test cutting in

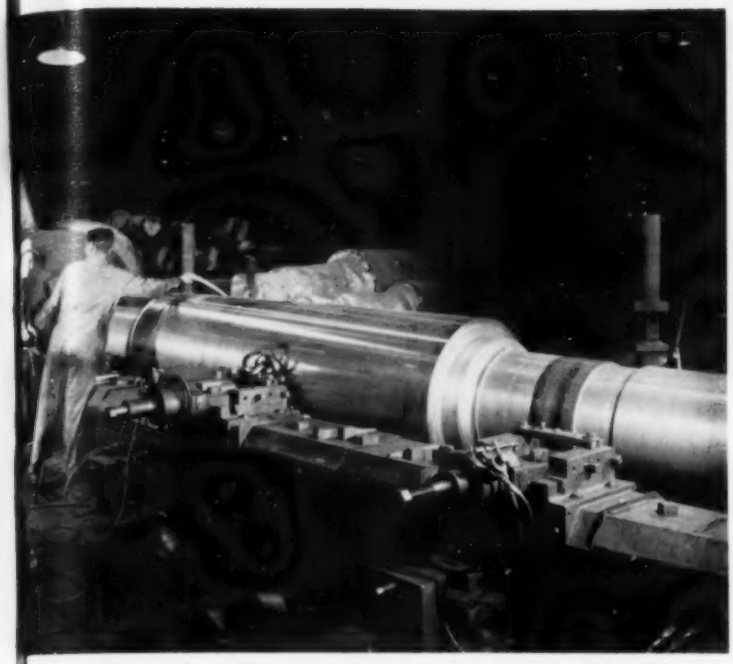


Figure 5 — Hydraulic plunge cut tools and hydraulic traverse on roll lathe have increased machining efficiency.

Figure 6 — Milling machine is cutting parallel flat wabblers on rolls.

critical portions of rolls which are not finish-machined before shipment. Hardness determinations are usually made with the Shore scleroscope. Hardness ranges are specified to cover five points Shore: for example, a requirement of 65 Shore would include the range 63 to 67. Considerable calibration work on the Shore instrument in recent years has been done by the rollmakers, and the accuracy of roll hardness testing has undoubtedly improved as a result. However, hardness is not the sole criterion of a roll's service performance, as many users can testify.

Inspection for internal defects by use of the supersonic method has been adopted by many rollmakers. Its use in cast iron and steel rolls above 2.00 per cent carbon is limited due to the sound scattering effects of the graphite and the free carbides. In the lower carbon grades of cast steel, the method is highly useful; and a 20-ft long blooming mill or backing-up roll can be readily inspected. Figure 7 shows the method of testing, in which a photographic record can be made of the supersonic chart. Figure 8 is an illustration of a chart showing the occurrence of an internal discontinuity in a steel roll. All of the supersonic indications are not open to complete interpretation; but this method of testing certainly prevents serious defects in cast steel rolls from getting into the user's mill.

Another inspection tool, used mainly for research, is the microscope. Roll studies have recently been made with the electron microscope up to 15,000 diameter magnifications. The micro-structures that occur in cast rolls cover the complete range of those usually found in such metals as carbon steel, alloy steel, plain chilled iron, gray iron and alloyed chilled and alloyed gray iron. Some of these structures are among the most complex found in metallography. It is definitely not a job for the novice to attempt to interpret the roll micro-structure in terms of performance, for such attempts have too many times failed even the most experienced roll metallurgists. The uniform micro-structure of a high tonnage blooming mill roll is shown in Figure 9. However, a roll with this same structure might possibly give inferior tonnage performance in another blooming mill. The 4½ per cent nickel continuous hot mill work roll has an extremely complicated micro-structure as shown in Figure 10. Here can be seen the hard carbides as the white constituent, the free graphite as the black constituent, and the gray matrix which has a composition and micro-structure not unlike a hardened alloy steel. This particular micrograph is from a record tonnage roll, but the authors would be the last to claim that other structures might not give equally superior results.

With these descriptions of molding, melting, heat treatment, machining and inspection, let us leave the manufacture of cast rolls and inquire into their many applications.

PART II — CAST ROLL APPLICATION

Before discussing the details of application, let us consider the carbon content of cast rolls because it is

Figure 7 — Supersonic testing of back-up roll is recorded by photograph of test pattern.

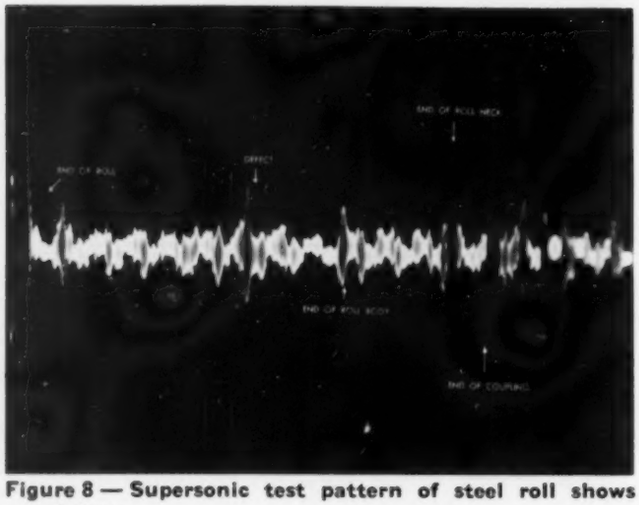


Figure 8 — Supersonic test pattern of steel roll shows defect.

the most important factor in determining roll performance.

Carbon in cast rolls ranges from a low of 0.25 per cent to a high of 3.80 per cent. The usually accepted metallurgical boundary between cast steel and cast iron is at 1.70 per cent carbon, but with cast roll compositions this boundary is not valid because of the complications arising from alloying and chilling. A fairly satisfactory definition can be based on the occurrence of free carbon or graphite in the micro-structure. Thus, it is stated that cast iron rolls are those containing graphite in the unchilled portions, while cast steel rolls contain no graphite in the unannealed state. See reference (2) in Bibliography. Cast steel rolls are found in the lower part of the carbon range up to about 2.60 per cent. Cast iron rolls occur in the upper portion of the range from 2.60 to 3.80 per cent carbon. There is a class of steel rolls in the higher end of the carbon range, from 1.80 to 2.60 per cent carbon, which due to low melting point is often cast from the air furnace like iron rolls.

As the carbon content of cast rolls is increased, the wear resistance increases but the strength decreases. In applications where great strength is required and some wear can be tolerated, as in blooming mill rolls, low carbon is a necessity and steel rolls are used. On the other hand, in cases where close tolerances must be maintained, as in finishing rolls, high carbon is required for wear resistance; strength must be sacrificed, and cast iron rolls are used. As a general rule, the carbon content of cast rolls increases from the roughing end to the finishing end of the rolling process.

In all the carbon ranges, the strength and wear resistance of cast rolls is increased by suitable and balanced additions of alloying elements, usually chromium, molybdenum and nickel. Other elements, such as boron, titanium and vanadium, may be added for special purposes.

Cast steel rolls are usually classified into grades on the basis of carbon content, as shown in Table I. Most of the steel rolls are supplied in alloyed grades, and in each stand the highest carbon content should be used commensurate with the strength required.

For cast iron rolls, the grades are usually classified on the basis of alloy content, method of manufacture, and character of chill. Most rollmakers list the grades shown in Table II.

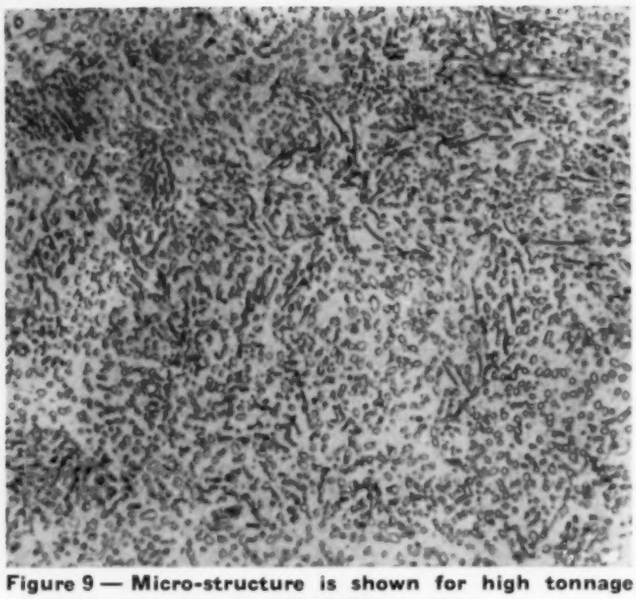


Figure 9 — Micro-structure is shown for high tonnage blooming mill roll. (1000 X Nital etch.)

There may be some roll users who are not familiar with the difference between chill type and grain type iron rolls. The essential difference is that the chemical composition of the grain type roll is so devised as to produce a scattering of graphite particles of microscopic size throughout the working surface of the roll, as shown in Figure 11. These small particles of graphite are about 0.001 to 0.005 in. in diameter, and hence are indiscernible to the naked eye. Their presence, however, seems to improve strength and resistance to fire cracking and

Figure 10 — Micro-structure is shown for record tonnage 4½ per cent nickel, continuous, hot mill work roll. (500 X Nital etch.)

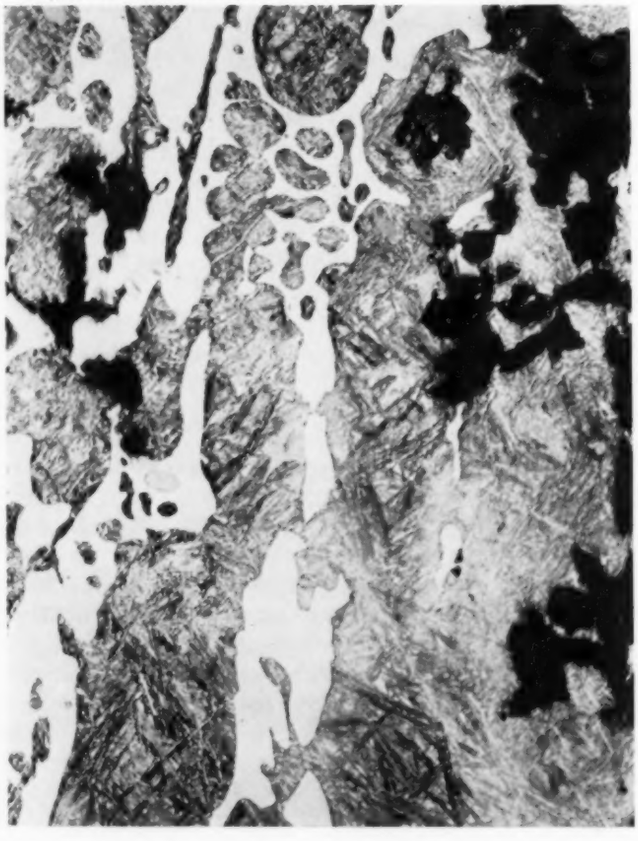


TABLE I

Cast Steel Roll Grades

Per cent carbon	Application
	Plain carbon steel grades
0.40—0.90	Blooming and roughing rolls of low cost.
	Alloyed cast steel grades
0.25—0.50	Special high alloyed and heat treated backing-up rolls.
0.40—0.60	High strength blooming and roughing rolls.
0.60—0.80	Blooming and roughing rolls.
0.75—1.00	Backing-up rolls, blooming and roughing, slabbers, plate roughing, structural roughing.
1.00—1.30	Lower strength, high wear, blooming and roughing, structural intermediates, slabbers, plate roughing.
1.30—1.50	Hot strip work rolls, 3-high roughers, structural intermediates.
1.50—2.00	Bar mill and rod mill roughers, and intermediates, deep section finishers.
2.00—2.60	Intermediates and finishers for large and intermediate shapes.

TABLE II

Cast Iron Roll Grades

Grade	Description and Application
Sand iron	Unchilled, low or no alloy. Special roughing mills.
Plain chill	Unalloyed chilled iron. Bar, rod, sheet, and miscellaneous mills.
Molybdenum chill	Chilled iron up to 1 per cent Mo. Hot sheet, hot strip and plate mills.
Alloy grain	Indefinite chill with Cr, Mo and low Ni. Bar, 2-high hot strip, rod, plate, structural, tube and pipe, and non-ferrous mills.
Nickel alloy grain	2 to 5 per cent nickel indefinite chill with Cr and Mo. Bar, hot strip, cold strip, rod, sheet, plate and pipe mills.
Nickel alloy chill	1 to 5 per cent nickel chill. Bar, plate, non-ferrous, rod, hot strip and sheet, and cold mills.
Double pour grain	3 to 5 per cent nickel chill surface. Hot and cold strip work rolls, plate mill work rolls.
Double pour chill	3 to 5 per cent nickel chill surface. Hot and cold strip work rolls, and cold sheet mills.

wear. Chill type rolls contain none of this free graphite in the surface layers.

Nodular iron is a new material, and its trial use in rolls deserves mention. It does not seem to be generally understood that nodular iron may include a considerable variety of chemical compositions; and that the only essential feature is that the graphite occurs in the shape of small spheres, rather than in the form of wavy flakes. Nodular iron rolls are often supplied by American and European makers who do not have the facilities for producing steel rolls which would be suitable for most of the same applications. The surface metal of nodular iron rolls is not always equal in strength and wear resistance to regular chill or grain rolls but the center metal and necks are undoubtedly stronger. Nodular grades seem to be giving their best results as intermediate and leader rolls in shape and bar mills.

Now let us examine the cast roll grades which are currently being used in some of the more important mill applications.

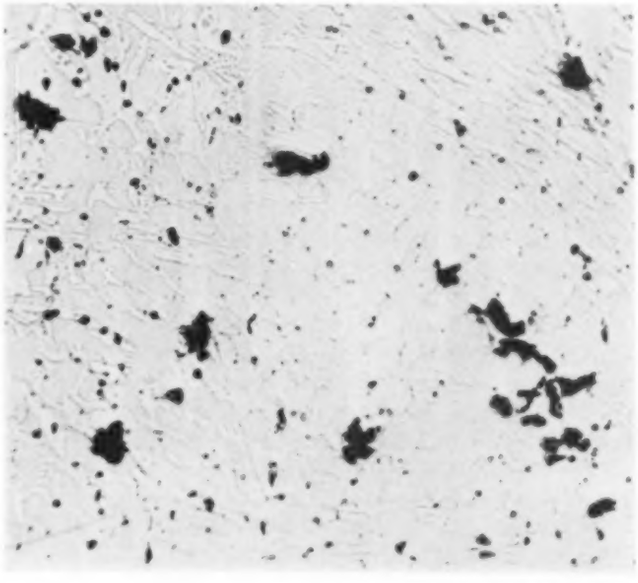
Blooming mill rolls — Blooming mill rolls require strength and fire cracking resistance, rather than wearing qualities. A few old mills use a 0.40 to 0.50 per cent carbon unalloyed roll with a simple annealing treatment. Most modern, two-high reversing mills use alloy steel rolls with carbon ranging from 0.70 to 1.20 per cent and with special heat treatments. The usual alloying elements are about 1 per cent chromium and 0.25 to 0.50 per cent molybdenum. Nickel up to 1.75 per cent appears to be beneficial in certain rolls, but many record breaking rolls have contained only residual amounts of less than 0.25 per cent nickel. A few exceptional blooming mills can use rolls with carbon as high as 1.80 per cent or as hard as 50 Shore for good side wear without experiencing breakage. The majority of blooming mill rolls will be found in the hardness range from 28 to 38 Shore.

The blooming mill rollmakers' art lies in balancing chemical composition and heat treatment to produce maximum strength and fire cracking resistance. In resistance to fire cracking, the maker is limited to a narrow range in the improvement of his product. Many mill operators appreciate this fact and realize that fire cracking can be most readily minimized by the proper control of heat, usually by well arranged water cooling.

Recently, some blooming mill rolls have been ragged with special surface patterns that are claimed to reduce fire cracking. Such patterns allow for the escape of the scouring steam, and provide for the local thermal expansion and contraction of the roll surface. The use of these patterns seems to result in considerable reduction of deep seated fire cracks; and this should materially increase the life of the rolls.

Structural rolls — Structural roughing mill rolls with complicated shapes must resist high heat and require great strength because of their deep passes. These rolls are usually made of alloy blooming mill mixes under

Figure 11 — Unetched micro-structure of grain iron roll shows characteristic free graphite. (100 X.)



1.00 per cent carbon. Billet roughers are usually not subjected to such severe loading, and the carbon content can be raised to the 1.60/2.00 per cent range with suitable alloying. Nickel additions are sometimes of distinct advantage in these rolls to increase toughness and hardness. In certain cases, special heat treatments have increased wear resistance and reduced fire cracking.

Tube mill rolls — Tube mill piercing rolls must have exceptional bite, and thus are generally made of low carbon, plain or alloyed, steel. Plug and reeler mill rolls should combine wear resistance with good bite. They are generally made of 50/60 Shore alloy grain iron for small diameter tube and pipe; and high carbon alloy steel for large diameter pipe. In sizing and reducing rolls, size and shape of pass are of prime importance. These are generally made of 65 to 75 Shore alloy grain or low nickel grain iron. Forming rolls in welded tube mills must often resist severe abrasion, and are made of many grades from 65 Shore alloy grain iron up to 85 Shore high nickel grain.

Merchant mill rolls — In merchant mills, the roughing stands usually take high carbon alloy steel rolls. These may have proprietary brand names with special mixes and treatments. For the intermediate merchant and bar mill stands, higher carbon alloy steel or alloy grain rolls are used. The finishing stand rolls may be alloy grain, plain chill or alloy chill.

The rollmakers provide a wide range of grades for these section mills, and the proper roll selection depends on factors such as the depth of section, the roll diameter, the rolling temperature and the amount of reduction. There are available high carbon steel rolls for the deepest sections; new deep penetration grain iron rolls for sections of intermediate depth; and hard grain and chill rolls for sections of shallow depth.

The relationship between hardness and depth in these grades is shown in Figure 12, which is an idealized curve and which would vary slightly with different roll diameters. In these grades, it should be remembered, that as the depth of penetration is increased, the hardness at the surface usually decreases; but, in the deep layers, the hardness and wear resistance is greatly improved. Thus, the surface hardness of the high carbon steel roll will rarely exceed 50 Shore, but this hardness level will be maintained without the occurrence of coarse graphite practically to the center of the roll. The deep penetration grain iron rolls will have a surface hardness of 54/62 Shore, and may have this same hardness at 1½ to 2½ in. below the surface. The regular grain and chill type rolls can have surface hardness ranging up to 72 Shore, but these values usually decrease rapidly to levels as low as 45 Shore at depths of ¾ to 1½ in. below the surface.

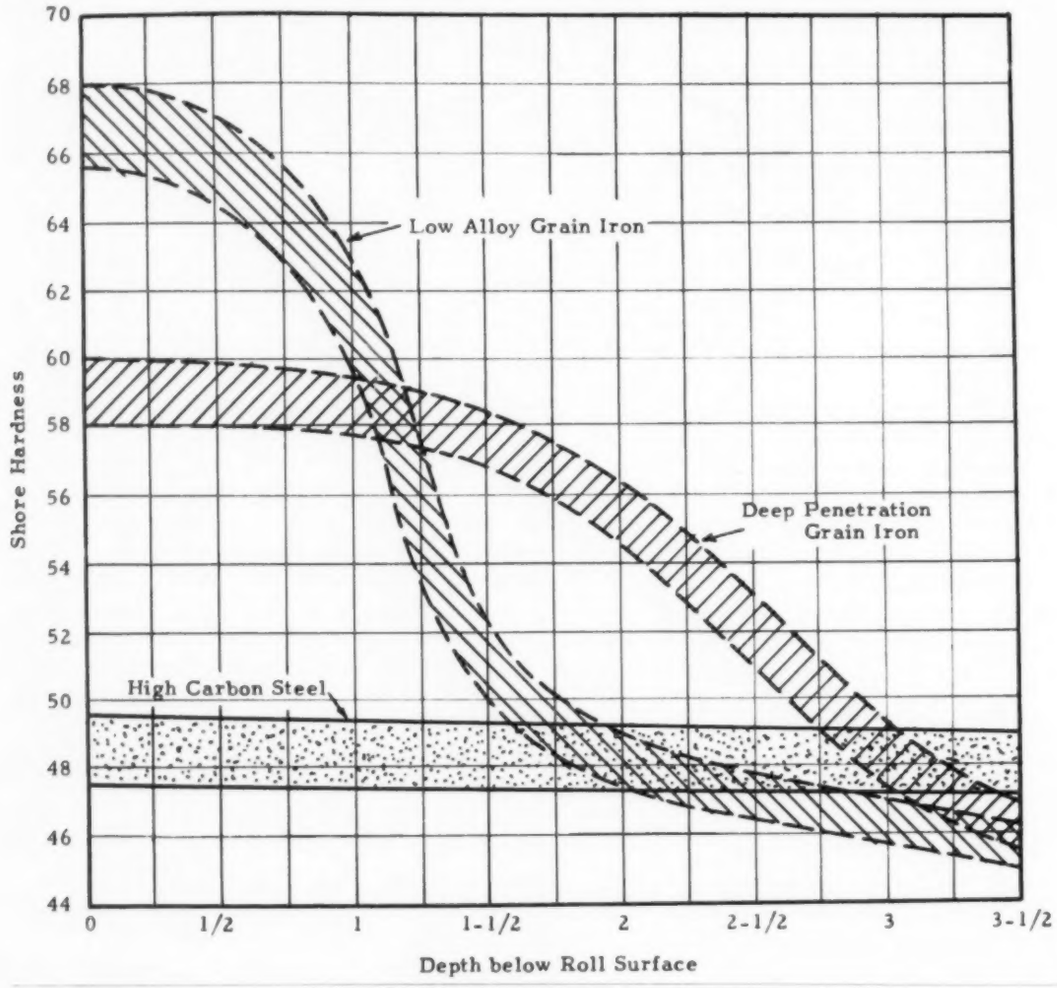


Figure 12—Chart gives depth of hardness in rolls for sections. Lower surface hardness maintains higher interior values.

Rod mill rolls — For rod mills, much the same rolls are available as for merchant mills. Roughers are usually furnished of the very high carbon steel rolls or the newer deep penetration iron grain rolls. Intermediates are generally alloy grain or plain chill rolls, while finishers are usually of the alloy chill type.

Slabbing mill rolls — Let us now consider rolls for flat products. Slabbing mills take much the same type of rolls as blooming mills. Because of their usually greater diameter, they can be made of harder, higher carbon blooming mill mixes from 0.80 to 1.30 per cent carbon. Certain large slabbing mills can use rolls with hardness as high as 45 to 49 Shore.

Plate mill rolls — Plate mills use a variety of roll types depending upon size, range of product, and whether 3 or 4-high. In the roughing mills, cast steel rolls of 0.50 to 1.00 per cent carbon, alloyed and unalloyed, are used. In the 4-high mills, backing-up rolls are of the 0.80 to 1.00 per cent carbon alloy steel grade from 42 to 49 Shore. Work rolls may be either alloy grain, low nickel grain, or 74/82 Shore double your rolls. The 3-high finishing rolls are usually of the molybdenum chill type; but if the finish of the plate can be comewhat sacrificed, may be of the stronger low nickel grain or double poured type.

Three-high sheet mill rolls — Three high sheet roughing mills generally use a high carbon roll in excess of 1.35 per cent carbon, suitably alloyed and specially heat treated. Hardness ranges from 38 to 48, with those values toward the higher range giving the best service. The 2-high sheet finishing mills still use the plain chill or molybdenum chill grades which give the best finish, although these grades are prone to heat cracks and breakage. When heat cracking and breakage become too severe in these mills, low nickel grain or chilled double pour rolls are sometimes used.

Skelp mill rolls — Skelp mill roughers are generally made of 1.80 to 2.50 per cent carbon, heat treated alloy steel at 40 to 50 Shore. The intermediate and finishing stand rolls for most skelp mills are made of alloy grain or low nickel grain at 60/70 Shore, although a few new high speed mills are using high nickel grain rolls at hardness up to 78 Shore. The edging rolls are made of alloy grain iron at 60/65 Shore. Heat treated high carbon steel rolls are sometimes used for branding where machining is a consideration.

Hot strip mill rolls — Continuous hot strip mills use a wide variety of rolls depending on the position of the stand and the required finish of the product. In both 2-high and 4-high roughing stands, the work rolls are usually of the 2½ per cent nickel grain type. This grade is also used in the early finishing stands. If the heat and strength requirements are extremely severe, alloy steel rolls as low as 1.00 per cent carbon may be used as roughers. The early finishing stands present a serious surface problem due to the high heat encountered. In these stands, a number of grades have been tried, in an attempt to avoid the too frequent mill changes that are necessary to maintain a quality surface, particularly with tin plate. A recent practice is the use of steel rolls of 1.00 to 1.50 per cent carbon, heat treated to 40/48 Shore hardness for work rolls in these stands. Double poured alloy grain iron rolls of about 74/78 Shore are also being used. Rolls for final finishing stands are of the double pour alloy grain type of 78/84 Shore. The tonnage performance of hot mill work rolls has been increased 25 to 40 per cent in recent years by special balancing of alloys, methods of casting, and heat treatments. Most 4-high hot strip mills use an alloy back-up roll of between 38 and 49 Shore hardness with very good success. In some cases of severe spalling, a harder backing-up roll of 58 to 62 Shore has been successful, but this type is not in general use in the hot mills.

Two-high cold mill rolls — Two high cold mill rolls are made of plain chill, molybdenum chill, nickel chill, or chill type double poured grades depending on the surface required, the grade of steel being rolled, and the stresses in the mill. In certain stands requiring high polish, no roll under 80 Shore is serviceable.

Four-high cold mill rolls — In the 4-high tandem cold mills, the double poured alloy grain iron work roll is giving a good account of itself primarily in the early stands. The advantages of this roll are that it holds a skid-proof surface resulting in less marking of the strip; less mill down-time due to less roll changes; less roll grinding; and more rapid mill threading. There are also advantages from the standpoint of delivery, and there is an outstanding advantage in roll cost. The disadvantages are that the cast iron roll is not of extremely high hardness and so may mar comparatively easily; also, the cast iron roll must be handled carefully during mill changes to avoid collisions and jars that may snap the relatively weak necks.

Backing-up rolls for cold mills are generally over 50 Shore. High pressure mills require higher hardness backing-up rolls to minimize spalling. Some light pressure mills can use the regular 0.80/1.00 per cent carbon alloy steel back-up roll at 40/49 Shore. In slightly higher pressure mills, the 50/55 Shore backing-up roll is successful, while the 58/62 Shore alloy cast steel backing-up roll seems to give the best service in the highest pressure mills. Iron backing-up rolls of the double poured type over 80 Shore are used in a few temper mills.

In all this discussion of cast roll applications, the statements have been general rather than specific. No two mills in the country are identical, no two rollers are alike, no two products to be rolled are the same, and no two roll manufacturers make their rolls in exactly the same manner. Consequently, almost any specific statement about roll application is open to immediate contradiction. Some years ago, one of the authors, becoming weary of the large number of repetitions of uses under the several grades in the rollmakers' cata-

Figure 13 — Iron work rolls for 4-high continuous sheet and plate mills are shown in a modern roll shop.

TABLE III

Various Roll Grades Used in Individual Applications

Grade	Users	Grade	Users
Bar Mill		**Plate Mill**	
Alloy grain	50	Double pour grain	10
Regular chill	14	Alloy grain	7
2½ Per cent nickel grain	10	Regular chill	7
2½ Per cent nickel chill	4	2½ Per cent nickel grain	4
Molybdenum chill	3	Double pour chill	3
Sand iron	3	Nickel chill	2
Hot Strip Mill		Molybdenum chill	2
Double pour grain	22	**Sheet Mill**	
Alloy grain	17	Regular chill	14
2½ Per cent alloy grain	13	Double pour grain	14
Nickel chill	7	Molybdenum chill	9
Double pour chill	5	Alloy grain	8
Molybdenum chill	3	2½ per cent nickel grain	3
Rail Mill Finishers			
Special plain chill	3		

logues, undertook a survey of iron roll grades in various mills with the results shown in Table III.

It is obvious that each roll user has his own particular choice of grade in his particular mill stand which he is satisfied is giving him the best overall performance and cost. It is also obvious from the above table that the roll user can obtain the best roll performance in his particular mill if he works in close cooperation with the rollmaker. In this respect, the authors reviewed their list of double poured work roll specifications and found over 78 variations in composition which had evolved from placing the roll of optimum tonnage in specific users' stands.

Roll research and development is contantly being carried on by the roll manufacturers, and this paper can be concluded with the thought that there is a constant effort by all the makers to provide the users with higher tonnage rolls, producing better surfaces, with lower mill down-time and lower roll costs.

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1. "*Isothermal Transformation Characteristics on Direct Cooling of Alloyed White Iron*," by ROTE, F. B. ET AL, Transactions of the American Foundrymen's Society, 1951.

2. "*Metals Handbook*," American Society for Metals, p. 58, 1948.

DISCUSSION

PRESENTED BY

LOUIS MOSES, Mill Engineer, Bethlehem Steel Co., Bethlehem, Pa.

C. E. PETERSON, Sales and Research Metallurgist, Rolls Division, Blaw-Knox Co., 41st and Willow Streets, Pittsburgh 1, Pa. (At time of presentation of paper.)

Dr. F. H. ALLISON, JR., Vice President, Rolls Division, Blaw-Knox Co., 41st and Willow Streets, Pittsburgh 1, Pa.

Member: I was surprised at the photomicrograph of Figure 9 showing the cast steel roll to see the carbide phase so well broken up. In several of the roll failures that I have investigated there has been a strong tendency for the carbides to have been the cause of the trouble. We have been led to believe by the manufacturers that this is a situation that we have to live with.

I realize that in these high carbon alloy steels that this carbide phase is difficult to remove but I wonder if we could have a clarification as to whether there is an attempt to break up that high wear resistance carbide phase to a less brittle form.

Louis Moses: In this paper, the authors generously give of their long experience in rollmaking as well as drawing upon their wide observations on roll usage. It is difficult indeed to find a "peg" upon which to hang a question. One comes to mind concerning the remaining effects of the dendritic structure after freezing from the melt, as located in the surface rim of a cast roll and which is believed to be not too readily discerned in depth by the microscope.

We are led to understand that subsequent heat-treatment entirely eliminates such freezing effects which, if they are present in a completed roll, would be arranged columnarly and perpendicularly to the surface of the roll-body. This could be compared somewhat to the bristles of a street-cleaner's revolving brush. The anchored dendrites (bristles) can be imagined to having their roots pivoted or hinged. The outside ends at the roll-surface would be free to deflect from their original radial direction when frictional loads are applied, as in the rolling action, and become bent away from the direction of rotation.

We are also told that any remnants of freezing-crystal growth on the surfaces of a cast ingot are completely eliminated when the ingot is soaked at 2000 to 2300 F. The metal's structure is thus described, not using metallurgical terms, as being completely and uniformly granular throughout the mass. Nevertheless, all mill men who supervise the rolling of ingots are consciously aware of the adverse effects resulting when and if this "green" ingot-skin is worked beyond what experience dictates as being safe in the initial passes. Manifestation in variable amounts occur to all grades rolled, some being more pronounced than others as reflecting hot-short characteristics. But after a few passes, the skin is physically rearranged in its structure which permits heavier drafting without similar surface damage.

Another observation lies in broken rolls of most any material, virtually every instance showing the fractured cross-section to have well defined radial appearances.

The varying states of wear resistance and particularly that of fire-cracking renders the question as being more than of academic interest. Discussion of this phase of the cast roll by the authors would be appreciated.

C. E. Peterson: In response to the first question concerning the carbide network or lack of it in micrographs, which we showed, the network carbide is or can be made to occur in any cast steel roll. It can be broken up sometimes — not necessarily at all times — depending upon the application of the roll. The rollmaker may or may not take definite steps to remove it.

In regard to the radial lines of which Mr. Moses asked, and also the broom straw phenomenon — that phenomenon I feel certain is a matter generally of segregation which is present in any metal. In rolling

strip steel or something of that nature, this segregation is fairly well broken up. In a casting, since there is no mechanical work, it is impossible to break up, so the rollmaker is faced with the problem of devising manufacturing techniques, pouring temperatures, working of the heat, chilling of the roll, and so on, to minimize or drive the segregation to such a depth below the surface that such segregation as is found will not interfere with the service of the roll, that is, the rolling surface.

F. H. Allison, Jr.: In regard to the comments on micro-structure in blooming mill rolls, I would not want anyone to think a network carbide in rolls is detrimental. I wanted to show there is such a thing in the micro-structure. Figure 9 shows a typical high service blooming mill which had this particular structure. Likewise the picture of the cast iron work roll (Figure 10) was an illustration of the varied type of micro-structures that occur. This roll gave a record service tonnage. Some other roll might have just as good a service record, but not show that particular structure.

As far as Mr. Moses' very interesting pattern is concerned, I think it looks something like the squeegee automobile tire. It ought to be pretty good in making things carry through the mill.

This pattern has very little significance in steel rolls, although it is there to some slight degree; but the heat treatment will erase most of it. One will find it in chilled iron rolls where the carbides follow the chilled pattern straight in; and also possibly in the nickel grain rolls, where the pattern is broken up considerably. It is not possible to eliminate the pattern in the chilled type roll.

CURRENT AISE DISTRICT SECTION MEETING NOTICES

BIRMINGHAM SECTION

Monday, January 31, 1955 — Dinner 6:30 P.M., Meeting 8:00 P.M.

"Design Factors for Steel Mill Tractors," by John A. Draxler, Manager, Service and Field Engineering, Elwell-Parker Electric Co., Cleveland, Ohio.

Thomas Jefferson Hotel, Birmingham, Ala.

BUFFALO SECTION

Tuesday, January 11, 1955 — Dinner 6:30 P.M., Meeting 8:00 P.M.

"Selection of Spare Parts for a Major Construction Program," by R. Boyer, Assistant Superintendent, Mechanical Dept., Bethlehem Steel Co., Lackawanna, N. Y.

"Problems Involved in the Operation and Maintenance of Steel Mill Equipment," by J. Oehler, Electrical Foreman of Strip Mill Electrical Maintenance, Bethlehem Steel Co., Lackawanna, N. Y.

Hotel Sheraton, 715 Delaware Avenue, Buffalo, N. Y.

CHICAGO SECTION

Tuesday, January 4, 1955 — Dinner 6:15 P.M., Meeting 7:45 P.M.

"Electrical Aspect of Variable Voltage Ore Bridges," by E. H. Gautier, Assistant Manager, Industry Engineering, Elliott Co., Pittsburgh, Pa.

Phil Smidt's Restaurant, 1205 N. Calumet Avenue, Hammond, Ind.

CLEVELAND SECTION

Tuesday, January 18, 1955 — Dinner 6:30 P.M., Meeting 8:00 P.M.

"Recent Developments in Shot Blasting of Strip Steel," by Kenneth Keska, Assistant Chief Engineer, Wean Equipment Corp., Cleveland, Ohio.

University Club, 3813 Euclid Avenue, Cleveland, Ohio.

DETROIT SECTION

Tuesday, January 11, 1955 — Dinner 6:30 P.M., Meeting 8:00 P.M.

Ford Steel Division Night

"Stamping Plant Automation — Its Effect on the Steel Industry," by R. Guthrie, Steel Division, Ford Motor Co., Dearborn, Mich.

Meridian Room, Dearborn Engineering Laboratories, Dearborn, Mich.

LOS ANGELES SECTION

No January Meeting Scheduled.

PHILADELPHIA SECTION

Saturday, January 8, 1955 — Dinner 6:00 P.M., Meeting 7:00 P.M.

"Power System Chicago District," by K. E. Dinius, Chief Engineer, South Works, United States Steel Corp., Chicago, Ill.

"Welding Clad Steel," by W. H. Funk, Manager, Technical Service, Lukens Steel Co., Coatesville, Pa.

Engineers' Club, 1317 Spruce St., Philadelphia, Pa.

PITTSBURGH SECTION

Monday, January 10, 1955 — Social Hour 6:00 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"Progress in Power Generation from Atomic Energy," by R. G. Lorraine, Atomic Products Division, Atomic Power Study, General Electric Co., Schenectady, N. Y.

Alumni Room, University Club, University Place, Pittsburgh, Pa.

ST. LOUIS SECTION

Data Not Available.

SAN FRANCISCO SECTION

No January Meeting Scheduled.

YOUNGSTOWN SECTION

Monday, January 24, 1955 — Social Hour 6:00 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"Erection and Operation of Blast Furnaces in Chile," by Thomas W. Plante, Assistant Sales Manager, William M. Bailey Co., Pittsburgh, Pa.

Mahoning Country Club, Girard, Ohio.

APPLICATION of LUBRICANTS

to Rolling Mills —

Problems, Developments and Trends

By WAYNE G. RITTER
Trabon Engineering Corp.
Pittsburgh, Pa.

. . . . lubrication systems should be designed as part of the mill . . . . and must also fit into mill maintenance procedures . . . .

▲ FOR more than a decade our iron and steel industry has been producing steel at unprecedented rates. New production records have been set on almost every mill in every plant. Such progressive breaking of tonnage records would indicate that in almost all cases the original production rates for which the equipment was designed were exceeded. Not only have the mills exceeded production rates on products for which they were designed, but they have also been required to roll products for which they were not designed. Such practices have, of course, accelerated deterioration of the equipment and hastened the date when the facilities must of necessity be replaced.

During the last fifteen years there has been a steady improvement in the practice of application of lubricants to this equipment. It was realized by operators and engineers that in addition to the usual reduction in maintenance costs and increased production time, years of life of the equipment could be added through good lubrication practices and an indeterminate return could be gained through prolonging the time when the facilities would have to be replaced.

Lubrication is "Big Business," perhaps bigger than most people realize. For example, one large corporation in this country spends over nine million dollars per year for lubricants, labor and devices to apply them.

There are many methods of lubricant applications to rolling mills, as for example:

1. Once through oiling.
2. Oil reservoirs.
3. Circulating oil systems.
4. Hand grease applications.
5. Grease gun — one point at a time.
6. Centralized grease systems.

Since the subject of this paper is a broad one, it will be limited to a specific phase of lubricant application — that of centralized grease systems.

Just as our modern utility systems have developed into centralized systems of distribution, so industry began to apply grease in central distributing systems. Of all the materials required to be pumped in modern industry, grease is the most difficult. Some abrasives or corrosive materials are also difficult, but these usually are maintained at uniform consistencies.

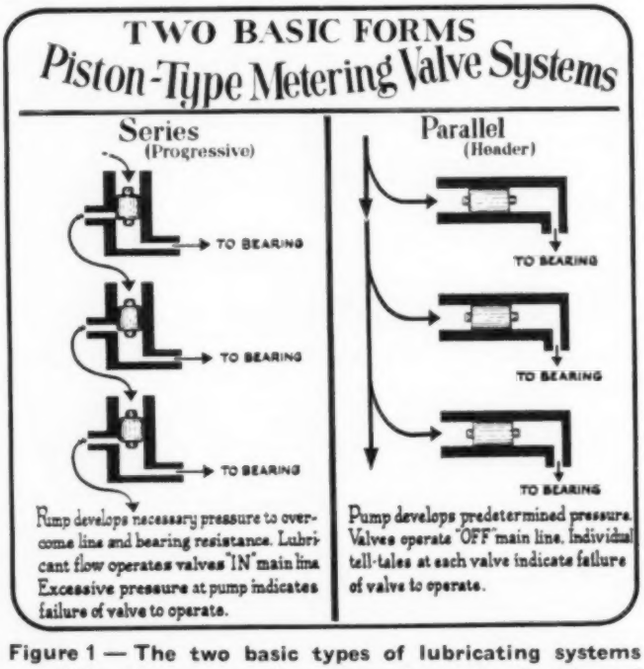
TWO BASIC FORMS
Piston-Type Metering Valve Systems
Series
(Progressive)
TO BEARING
TO BEARING
TO BEARING
Pump develops necessary pressure to overcome line and bearing resistance. Lubricant flow operates valves "IN" main line. Excessive pressure at pump indicates failure of valve to operate.
Parallel
(Header)
TO BEARING
TO BEARING
TO BEARING
Pump develops predetermined pressure. Valves operate "OFF" main line. Individual tell-tales at each valve indicate failure of valve to operate.

Figure 1 — The two basic types of lubricating systems differ from each other primarily in the location of the valve pistons as related to the lubricant transmission line.

Grease is compounded and sold by many manufacturers, large and small. Through the years these manufacturers have developed specialized greases for special

purposes, all with considerable variation in properties. In order to apply any or all of these greases to moving parts of machinery through centralized piping systems, it was necessary that pumps and valves be developed.

Over the past twenty-five years two basic types of valving systems have been developed. These are shown schematically on Figure 1.

Fundamentally, the two types of systems shown in Figure 1 differ in the location of the valve pistons with respect to the lubricant transmission lines. The series systems have valve pistons located "in" the lines. The parallel systems have valve pistons located "off" the transmission lines. In order to transmit lubricant in a series system it is necessary that each valve piston make a full and complete stroke. In the parallel system the action of the valve pistons does not affect the transmission of the lubricant throughout the system.

From these two principles can be evolved all of the characteristics of the two systems. For instance, it will be seen that since valve pistons need not make a full stroke in the parallel system that some means must be found to indicate whether, and how much of a piston stroke was made. In the series system, since valve pistons are moved progressively for a complete stroke under full pump volume and pressure, indicators on individual valves are not required.

Variations in feeder valve design by several manufacturers built around the basic principles discussed above have come about through a consideration of the manner of returning the valve piston to its original position and simultaneously reloading or precharging for the succeeding valve operation. Figure 2 shows two design variations of the parallel or header type system.

It will be seen that in a two-line header system that the valve piston is returned by the employment of alternating hydraulic pressure on either end of the piston. In the single line header system the valve piston is returned to its original position by means of a spring.

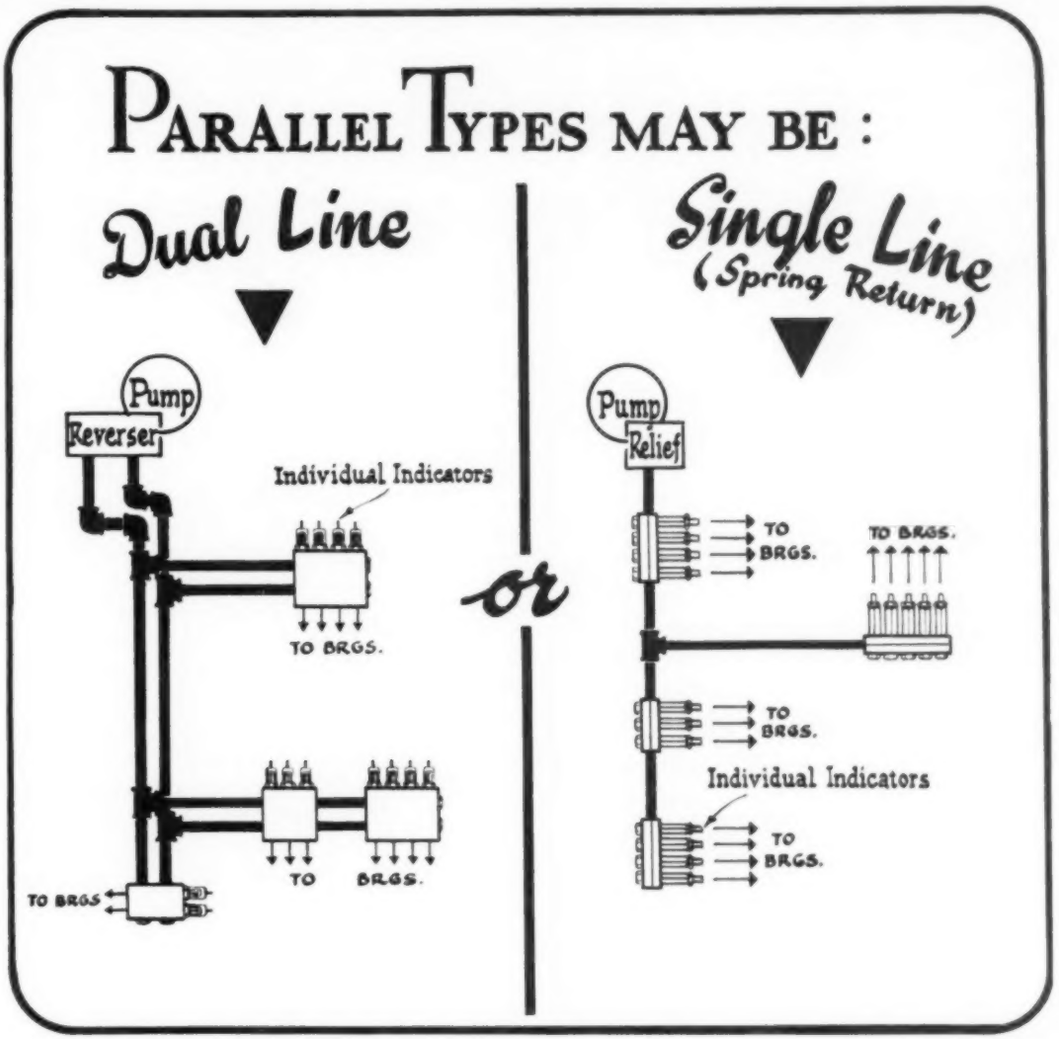

Figure 2 — Two common variations of the parallel system are the dual and single line.

It will be noted that both of these systems require indicators on each valve piston to show whether or not the valve piston operated.

In Figure 3 are shown two design variations of the series or sequence system.

The manifolded series type system employs an internal porting arrangement to bring alternating pressure to bear against either end of the valve piston. It will be noted that this manifolded series system does not require any device or means at the pump to reverse the flow of lubricant. The reversing type series system employs a reversal of lubricant flow direction to return the valve piston to its original position.

These then are the simple basic operating principles of all systems now in general use. In summary, Table I cites the following general characteristics and differences:

TABLE I

Series or Sequence Type	Parallel or Header Type
1. Fluctuating pressure at the pump gage, developed as necessary.	1. Fixed maximum pre-set pressure at pump or end of line.
2. Full pump discharge volume and pressure exerted directly against each valve piston.	2. Pump discharge volume and pressure exerted in the header line with valve pistons operating as this pressure exceeds resistance to piston movement.
3. Pump is connected directly and individually to each bearing port in sequence.	3. Pump is connected to all valve pistons simultaneously as the header pressure reaches its maximum.
4. Bearings are lubricated in progressive sequence regardless of resistance to flow in the piping system and bearings.	4. Sequence of application of lubricant to bearings depends upon resistance to flow in the piping system and bearing, valve piston moving against lowest resistance operates first, etc.
5. Each valve piston must make a full stroke for continued system operation.	5. Valve pistons may make full, partial or no stroke without affecting system operation.
6. Comparatively small main lines for transmission of lubricant.	6. Comparatively large main lines for transmission of lubricant.
7. Low volume lubricant pumps to reduce dynamic head.	7. High volume lubricant pumps to bring header lines to pre-set pressures quickly.

None of these systems are complicated either in operation or in principle. They need not instill confusion in the minds of the operators, engineers or maintenance personnel. They serve one, and only one, purpose — they lubricate and save bearings.

PROBLEMS

Experienced mill operators know that the first symptoms of impending high maintenance costs in their mills first appear in the breakdown of their lubrication practices. A lubrication system is no better than the personnel who are responsible for maintaining it. As in all other lines of endeavor, the primary problem evolves about this animal known as "Man." No longer is it possible to expect any man to be given a job classification of "grease monkey," pay him little better than the basic wage rate, and expect him to maintain the modern lubrication systems. For some reason this is exactly what is expected in some mills. Yet, no one would think of assigning an untried man to the controls of a hot strip finishing train without thorough training and experience.

In most mills there is a fairly rapid turnover of lubrication system maintenance men. This is only natural, since most men have a desire to improve their status and advance in earning power and responsibility. In order to meet this problem of rapid turnover of personnel, it is important that good solid basic training in lubrication be continuously given to the men coming on the job, at least until such time as a better wage rate is established with resultant stabilization of this particular labor force.

Management in one of the large steel corporations have recognized this weakness in their maintenance structure and during the past eighteen months have instituted a continuing program of lubrication training for not only hourly men but for supervisory personnel as well. Dividends will most surely accrue to companies who institute and carry out this practice. It is believed that some of these dollars would be well spent if used to increase the wage rate.

There is another very important key to successful maintenance — good housekeeping. Just as a man takes pride in his newly washed automobile, so he works better in a clean, well painted grease and oil house. The condition of a grease system can almost be predicted by an inspection of the pump station. If supervisory maintenance personnel will enforce cleanliness and neatness at the pumping station, the level of maintenance of the systems will appreciably rise.

Another problem which confronts both the manufacturer of grease application equipment and the mill operators is that of grease pumpability. No lubricant is useful unless it can be transmitted to the moving part for which it is intended at the right time. Until very recently there have been no standards set for pumpability. None of our technical societies which normally develop such standards have made studies and recommended standards of pumpability. One corporation has developed its own standards for grease pumpability for centralized systems in steel mills. A standard of 0.1 gram per second at 0 F as a minimum for acceptance for use in their mill centralized systems has been established. The apparatus and test developed by this company were described in a paper presented at the 1953 Annual Convention of the Association of Iron and Steel Engineers in Pittsburgh and published in the October 1954 Iron and Steel Engineer. See "Pumpability of Steel Mill Greases," by J. S. Aarons and R. G. Warren.

It matters little whether a mill has the parallel or series type systems in use, greases with poor pumpability characteristics will surely cause trouble, especially during periods of low ambient temperatures.

If a plant has series type systems, a grease with poor pumpability characteristics will first be indicated by abnormally high pressures at the pump gage. If this pressure reaches the pressure limit, there ensues a period of "on" and "off" pump operation as the grease is slowly forced through the piping system. The pump must therefore labor for a longer period of time to get all the bearings served than would normally be true using a grease with good pumpability characteristics.

If a plant has parallel or header type systems, the time required to reach the fixed maximum pressure at the pump will be changed and some of the valve pistons may not operate if the resistance in some lead lines to bearings is too great.

In either type of system, the bearings will not receive lubricant if the pump pressure will not overcome the total of the resistance to flow in the piping system and the resistance to flow into the bearing. This could be a serious situation and one which could be avoided with proper lubricants. Some will say that in this case the grease is being designed for the system and not for the bearings. The best lubricant that can be purchased is of no use whatever if it never reaches the bearings, in small regular applications, at the right time. Since grease pumpability appears to be influenced by the

viscosity of its base oil, greases are manufactured which will easily pump and have good performance in the bearings.

With the increased use of centralized lubrication systems, it was natural that many improvisations would be made using available plant equipment. Such practices, although accomplishing their purpose, in some cases led to the creation of unsafe conditions because of improper choice of piping materials.

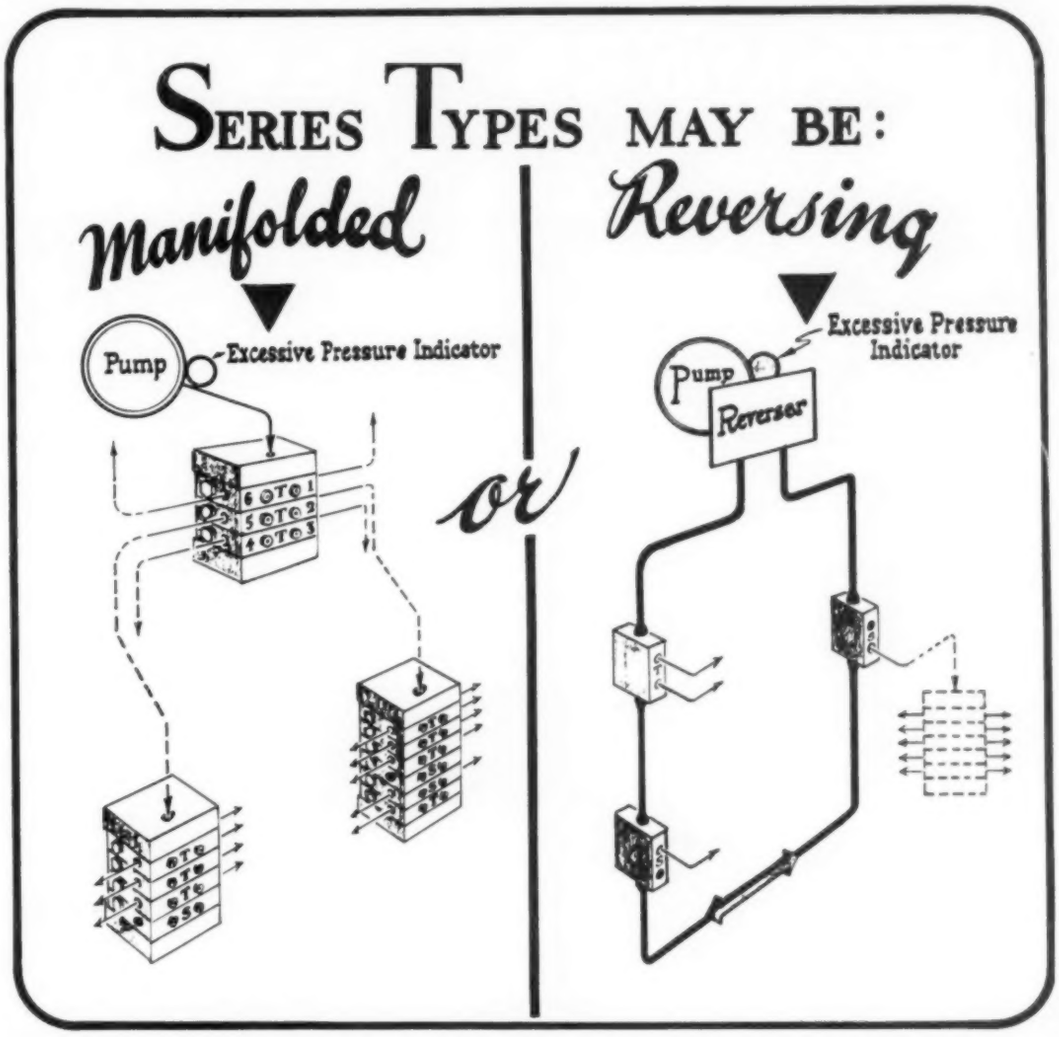

Figure 3 — The series system is normally either manifold or reversing.

In designing piping systems, two design considerations must be taken into account: designing for flow and designing for safety. As for flow design, the recommendation of the equipment manufacturer should be followed for his particular type of system. For safety design, there is no standard code for grease piping systems as such. The American Standard Code for Pressure Piping published by the American Society of Mechanical Engineers is not intended to include standards for grease piping systems. Piping recommendations of the equipment manufacturers are based upon their own tests and experience. To our knowledge, during the past twenty-five years there have been no serious accidents attributable to the failure of a conventional centralized grease piping system.

Grease as a pumpable medium more closely follows the characteristics of plastic flow than the laws of hydraulic flow. It is slightly compressible to the magnitude of 1 to 2 per cent. If there is entrapped air in a piping system, then this figure would not hold; but assuming no entrapped air, the larger the volume of grease in the closed pressure vessel, the greater the total expansion in volume if the vessel is ruptured. For this reason, as pipe size increases, piping safety factors should be likewise increased. It should be borne in mind, however, that the same safety factors used in the calculation for pressure piping of air, steam, and oil need not be used for grease since it is not a dynamic hydraulic medium; it has relatively little compressibility; and pressure is quickly dissipated in case of rupture of the vessel. This latter statement should be qualified in that the use of high volume, variable flow pumps will, upon sudden relief of vessel pressure, tend to rapidly rebuild this pressure with a resultant surge through the system.

Pressures required to introduce grease into bearings are often high. It is not uncommon to observe a man with a hand-grease gun exerting a pressure as high as 10,000 psi on the hose and fittings, yet this is not termed dangerous. Pressure is dangerous only when it is acting upon an area of such size as to develop a total force which becomes dangerous. There is so little volume of grease involved with the hand gun that even if there should be a rupture of its hose or fittings, no damage would be done. A parallel can be cited when one considers that a bicycle tire and a large truck tire have about the same internal pressure, but in case of blowout there is much more of an explosion with the truck tire than with the bicycle tire.

For piping systems with ½-in. pipe size or smaller, and where pressures do not *exceed* 4000 psi *at the pump*, standard black pipe or comparable strength brass pipe has been found to be satisfactory. Steel tubing can be used for main lines up to ⅝ in. outside diameter with a minimum 0.049 in. wall. As the pipe size increases above ½ in., it is good practice to use extra strong pipe or heavy wall tubing because of the larger volumes of grease involved in the main line headers. For lead line piping, from the valves to the bearings, ⅜ in. outside diameter steel or copper tubing with a minimum 0.032 in. wall has been found satisfactory. Either flared or flareless tube fittings can be used for lead line tubing lines. Pipe fittings used with the systems should correspond in strength to the type of pipe being used.

The use of double extra strong pipe for commercial centralized grease systems is not recommended, especially in ½ in. size. It does not meet the requirements of a balanced design between flow and safety. It can be used in those cases where flow design is not a factor, as in improvised systems.

Commercial grade steel pipe if used should be pickled before installation and blown out with air or steam before being filled with lubricant. If the pipe is not pickled, line strainers should be installed at critical points in the system. Galvanized pipe is never recommended for use in any centralized system. The flaking off of the coating is a continuing hazard to valve operation.

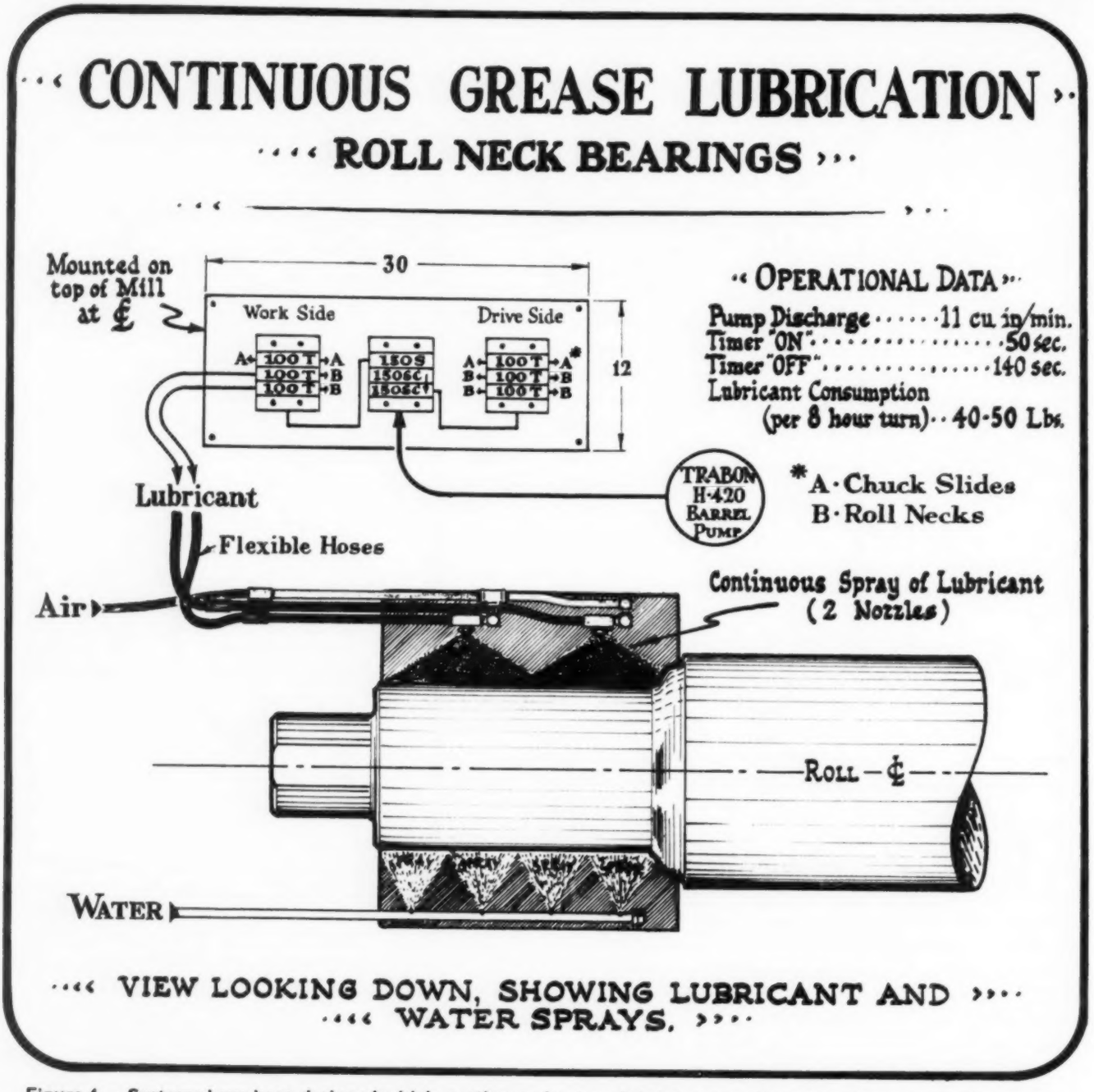

Figure 4 — Systems have been designed which continuously spray lubricant on roll necks under a controlled cycle.

DEVELOPMENTS

The controlled spraying of open gearing using solvent type or "cut back" lubricants is a fairly recent develop-

ment and, of course, well known to the industry. A further application of this method of introducing heavy lubricants to bearings has recently completed its test period and is being extended. This application is continuous controlled spraying on rolling mill roll necks. The method is shown in Figure 4. In this system, a manifolded series type, lubricant is pumped through a ½-in. pipe some 100 feet to a feeder valve which divides the flow into two parts in the ratio of 2:1; thence into a secondary feeder through ½-in. pipe to either side of the mill (twice as much to the drive side). The secondary feeder valve divides the flow to separate lines to slides and roll necks. The lubricant to the roll necks is introduced into pneumatic atomizing nozzles mounted on a manifold located a few inches from the neck surface. Even though the pumping cycle at the pump station is not continuous, there is a continuous fine spray at all times issuing from the nozzle. Because of the fine film of lubricant on the neck, it must be continuously maintained, since the wiping action of the bearing and the application of water tends to remove the film of lubricant.

The mill on which this method was tested extended the bearing life on the roll necks five fold over the plain application of grease by conventional methods.

TRENDS

Centralized grease systems employing manual lubricant pumps are gradually disappearing and are being replaced by automatic systems. These automatic systems are powered by pumps using electric motors, hydraulic fluid, mechanical drives, or compressed air.

Transferring of lubricant from barrels into system pumps is done in most plants by means of air powered equipment, which has replaced manual transfer pumping equipment.

For crane systems, there is developing favor for a centralized feeder system with one point of application. The crane filling station is established at a central point on the crane runway. The crane comes to this station and the crane operator greases his crane by simply connecting a hose to the one point of application on the feeder system. The pump is located at ground level and can be either air, electric or hydraulic powered. An indicator is used to tell when the system has completed application to each bearing. This method is a solution to the problem of keeping manual pump reservoirs filled by means of men carrying portable packs from the lubricant house up to the crane, a job which is tiresome and easily neglected by the maintenance men assigned to the job.

Just as individual motor drives have replaced overhead line shafts and belting drives, so are individual automatic systems replacing some of the large inflexible centralized grease systems. One plant in the eastern area, for example, uses an individual grease pump and centralized system for each of its six finishing stands in their hot strip mill. This gives close automatic control of lubricant input to the bearings.

In considering the many years of production ahead of present facilities and facilities about to be purchased, engineers and operators should place more importance on the lubrication application equipment as an important factor in future production costs and life expectancy of facilities. It should not be kicked around as a "gadget that comes with the mill" but rather specifications should spell out exactly what is needed so that it will fit into existing and contemplated maintenance plans and procedures.

DISCUSSION

PRESENTED BY

E. S. REYNOLDS, Professional Engineer, Manufacturer's Service Dept., Socony-Vacuum Oil Co., McKees Rocks, Pa.

ANDREW CICHELLI, Lubrication Engineer, Construction and Engineering Depts., Bethlehem Steel Co., Bethlehem, Pa.

WAYNE G. RITTER, Trabon Engineering Corp., Pittsburgh, Pa.

E. S. Reynolds: Mr. Ritter's excellent paper has brought up three very important subjects; namely, (1) the importance of proper training of plant personnel; (2) the desirability of suitable incentives to attract the interest of high-quality personnel, and (3) the importance of "good housekeeping."

It would seem that another very important point to be considered would be the desirability of including the installation of a suitable centralized grease system by the machine builder along with the design of the unit, rather than to consider it as an accessory to be added in the field as an afterthought. By incorporating such in the design of a unit, much more satisfactory results could be obtained, which would minimize many of the problems which develop as a result of added installations to equipment in the field.

Mr. Ritter has stated that "grease pumpability appears misleading and it would be wise to add to this statement, to be a function of its base oil." This might be that the percentage of soap, and the general structure of the grease has considerable effect on the pumpability of a grease. The term "pumpability" usually is referred to in the term "apparent viscosity," which takes into consideration all these factors.

The grease for a centralized grease system should not be selected on its pumpability alone, but on its slumpability, and its resistance to separation as well as its "apparent viscosity" or pumpability.

The slumpability of a grease has reference to the tendency of the grease to seek its own level, and is important at the pump suction of the centralized grease system. A grease with poor slumpability will tend to cavitate and will not feed properly into the system.

Under certain conditions, greases tend to separate into their main components, oil and soap. The application of pressure alone does not cause separation, but appreciable separation can occur under even low pressure if small clearances are present that permit the oil to filter away while retaining the soap. Separation can occur in grease pumps and feeder valves of centralized systems, and soap can accumulate in these elements, and also can be pumped into and accumulated in supply and discharge lines. The soap may clog the lines or interfere with valve operation. Eventually, parts of systems or entire systems may be made inoperative.

Therefore, only greases having good resistance to separation should be used in centralized grease systems.

A word of caution would be timely concerning the changing in brands of grease installed in a system. It is desirable to clean the system as thoroughly as possible, especially if the system has been in operation for any great period of time, or if trouble has been experienced with grease in use. A new grease tends to purge a system; it may loosen deposits which have already formed, and cause trouble in the feeder valves. This does not necessarily indicate that the new grease introduced is separating, but has probably been purging the system of deposits previously formed.

In the selection of a grease for a centralized grease system, a reputable supplier should be consulted, and they can advise whether or not a particular grease of their manufacture has correct pumpability, slumpability, and proper resistance to separation and will provide proper lubrication when it reaches the final point of application. As Mr. Ritter points out, the grease should not just be one designed to handle properly in a centralized grease system, but also should be correct for the bearing or part which it must lubricate.

A. E. Cichelli: Mr. Ritter is to be congratulated on a fine treatment of an important subject, and several observations come to mind:

1. *We agree lubrication is big business.* It is no news that Bethlehem Steel Co. and most of the steel industry is fully aware of that fact. Most plants have complete lubrication organizations headed up by an engineer, reporting to the maintenance superintendent. These groups are responsible for many phases of lubrication activity, among which are:

a. Reduction in maintenance cost of lubricated equipment.
b. Reduction in the expenditure for lubricants.
c. Selection and maintenance of lubricating appliances which, of course, includes grease systems.
d. Safety considerations in the application of lubricants.

As you can see, there is ample opportunity for the lubrication engineer to use good judgment. So often he may have to sacrifice one factor to achieve a greater overall gain. There is no simple rule-of-thumb that applies in every instance. As far as grease systems are concerned, we can, in general, say without question that the centralized grease system has materially reduced cost as well as the safety hazards in lubrication of steel mill equipment. Example after example can be cited, if necessary. Many of them are already recorded in the AISE proceedings. What I would like to emphasize above all is that untold millions have been saved in maintenance due to the advent of grease systems. For the few instances where a system might not have been necessary, there is an overwhelming preponderance of applications that have paid off over and over again. Bethlehem Steel Co. has not been remiss in availing itself of this maintenance tool at every opportunity. All new equipment is carefully scrutinized for possible application; while all old equipment is gradually receiving the same scrutiny.

I might add at this time that we do not concur entirely with the comments of Mr. Reynolds that the mill designers should design the grease system. We have had experience where that has been attempted, and is still being done, much to our chagrin. We generally find that when the system reaches us it is designed for the machine and not for the conditions it has to withstand. Besides, there are times the system reaches us in parts instead of one piece.

2. The next observation has to do with the relative merits and demerits of the two principal systems described. Speaking for a company embodying many points of view and utilizing thousands of systems, we find that each type of system performs adequately to warrant continued use. This does not mean they have no weaknesses, each it seems, has its faults and it remains for designers, operators and maintenance men to take notice of them and act accordingly. For example: due undoubtedly to the higher pressures involved and the many moving valve parts, maintenance has been a factor to consider in the sequence system. The higher pressures require a more rugged pump and closer fits and tolerances throughout the system. On the plus side, by the very nature of the system, worn valves are detectable at the pump since this results in a change in the duration of the cycle. This is not as easy to do with the header system since cycle duration is not affected materially by valve wear. We presume in this discussion that pressure signal devices and/or recording charts are used on automatic systems. Most manual systems have either indicators or gages. In the header system, what is considered an advantage, in the sequence system reliance on the valve indicator to spot trouble can turn out to be a serious disadvantage. If valves are installed carelessly so that indicators are not within easy view, or are located where dirt can jam them, then failure will come without warning since there is no other indication at the pump, excepting the one instance of main line rupture. The fact that all other bearings except the one that failed are receiving grease is small consolation if a delay occurs. Obviously it follows that a regular schedule of indicator inspection is necessary.

Another important consideration is the fact that the system pressure is limited higher in the sequence system, and much lower in the header system. For this reason it is important that plain bearings be designed for grease entry into an unloaded zone. We have received new equipment with grease connections right in the middle of the load zone with no distribution groove of any kind. In a header system, the load is sufficient to force the valve piston back. In a sequence system, if the load is too high, the system will block until the load is released. Recent roll-neck bearing studies seem to indicate that this item is an important factor in bearing performance. Incidentally, anti-friction bearings are not as adversely affected in case of system failure, which would take a relatively longer period of time to cause trouble.

So far we have called attention to possible troubles, and for a very good reason. All systems work beautifully as long as vibration is amply accounted for, as long as grease is not contaminated, as long as grease pressure is sufficient to enter the bearing, etc. Unfortunately, mill conditions are severe and to see that systems function as they should becomes a continuous battle.

Speaking of contamination, besides causing valve wear and thereby affecting grease delivery, this difficulty may also cause grease to bypass a valve entirely by making one or more of the pistons stick. Though

this can happen without warning in either system, it is much more likely that the sequence system will block and thereby give indication at the pump, whereas the header system is more vulnerable to this type of difficulty.

From the foregoing we must conclude that it is imperative to design a system to offset its inherent weaknesses. We have found it vital to use strainers in transferring grease to the system pumps. In sequence systems, where contamination can cause complete havoc, the use of pickled steel pipe or brass pipe and copper tubings has been found to eliminate this problem entirely.

Valves or feeders must be located where they are easily accessible and protected against damage. In the header system it is of paramount importance to permit regular indicator inspection. Furthermore, all lines must be adequately secured to counter vibration and shock effects. The number of points on reversible sequence systems may have to be limited to keep the pressure down. Some plants have found it advisable to use extra large main lines in the header system for easier low-temperature pumping.

Generally then, each system has limitations that must be appreciated by the designer, by the oiler and by the maintenance crews. Each type has to be handled differently so that its best performance can be realized.

3. The author's comments on training for lubrication maintenance men and their recognition as important cogs in the whole structure is still a problem in some quarters; but it is gratifying to know that most plants are cognizant of the condition and are doing something about it. Bethlehem is no exception. Most of our plants have regular instruction courses and, most important of all, replacements and new employees are just as carefully screened as any craftsman would be.

4. The question whether a grease should be designed for the system or the bearing is quite a serious one. Our author states that there are different greases that will pump easily and still give good performance in the bearings. I find only one fault with that statement: how good is "good"? We have blooming and slabbing mill bearings that consistently last, while rolling one million tons. We have others that last 250,000 tons. Each is accepted as "good" performance for the specific installation. A study of many mills points to the fact that on similar applications the important variables are bearing design, technique of grease application and finally the grease itself. We do not agree that it is perfectly all right to design a grease system and then pattern the grease to work in the system. Although our experience shows that extreme pressure or graphite greases have given no better results than plain lime-soap grease on many of these heavy-duty mills, we still contend that the first consideration is the need of the bearing, and the system should be designed around it. After the needs of the bearing are satisfied, then the product should be given as good pumpability properties as possible without sacrificing its lubrication characteristics. It is only at very low temperatures that pumpability trouble develops. If the system is designed to anticipate this condition, when using the grease required by the bearing, then there should be no difficulty at low temperatures. If, however, to do this would be impractical, it will then be necessary to provide a winter grade. Resistance to soap separation is another important item — and a problem for the oil people. By taking this stand, we are not ignoring the fact that systems require somewhat different greases than other application techniques would require. We are simply pointing out that accommodating the vagaries of a grease system does not give anyone license to ignore the bearing which should be the prime consideration.

5. As for piping, I agree with the author that the hazards involved in the pumping of grease are minor, therefore, I see no need for establishing a rigid code as in hydraulic equipment. However, I believe it is necessary that, regardless of the size and wall thickness, all steel piping be pickled and that piping or tubing be adequately secured. Cast fittings are undesirable.

6. Under the heading, "Developments," the author discusses spraying of roll necks. Can the author tell us how the thrust collars performed with this type of lubrication? How effectively was the scale kept out?

E. S. Reynolds: Mr. Cichelli's comments indicate that he has had an unfortunate experience with the installation of a pressure grease system by a mill builder. The point which I had in mind, and I think you can appreciate, is that many of your mills are today coming out with really quite a network of piping and other equipment on them.

For instance, it is not unusual to see a stand with piping for a hydraulic system, piping for either water, soluble oil, or some kind of roll coolant, and you have your electrical conduit, and oftentimes oil lines for your back-up roll bearings of the oil film type.

If in the design of the mill, facilities are not provided for the installation of grease lines, metering valves, and other centralized grease system parts, you will find that they are sometimes installed at inaccessible points where it is difficult to properly maintain them.

I think there should be a closer cooperation between the equipment builder's engineering department, and the engineering department of the centralized grease system supplier. Between them they could do a much better job on new equipment than by trying to add it in the field as an afterthought.

One other comment. I think you mentioned that you were having as good success with straight lime soap greases than with extreme pressure or heavy duty greases. The only place where you have limitation on lime soap grease are high temperature applications, because the general run of straight lime soap greases are limited usually to a maximum temperature of approximately 165 F. Above that you are liable to have separation with conventional lime soap grease unless it is combined with some other soap, or additive material which tends to hold the two together.

Wayne G. Ritter: Mr. Cichelli's question concerning the thrust surfaces on the roll necks relative to the grease spraying method discussed in the paper gets to the base of the problem of roll neck lubrication. The principal reason for installing the spraying method was to lubricate the thrust surfaces. Using the conventional means of introducing lubricant to these roll necks, the thrust surfaces were not being well lubricated which resulted in short bearing life in the mill — about three weeks in this instance.

By directing a segment of the spray against the thrust surface a lubricant film was continuously maintained

and at latest writing these same bearings are lasting about 16 weeks.

Scale is excluded from the bottom bearing by the use of a wooden block which might be described as a simulated bearing cap. It has a slot for inspection and a hole for a water spray pipe. This exclusion of scale has also contributed to the increased bearing life. On the top roll, the water spray acts as an envelope and deflects any flying scale away from the bearing surfaces.

Mr. Cichelli, in his remarks, may have left the impression that sequence systems have many moving parts in their feeder valves. To clarify this point for the record, we would like to point out that the valve used in the manifolded series type system has only one piston (moving part) for each two bearing lead lines which is one-half moving part per point of lubrication. In contrast, the valve used in the two-line parallel system has two pistons (moving parts); a diverting piston and a measuring piston which forces the lubricant into the bearing lead line or two moving parts per point of lubrication. The valve used in the reversing series system and the one to which Mr. Cichelli no doubt has made reference has one measuring piston, two diverting pistons, and a loosely fitted piston checks at each end thus making a total of five moving parts per two points of lubrication or 2½ moving parts per point.

I would like to say a word about the engineering of grease systems by the mill builder. There is one mill builder in the Pittsburgh area who details the grease system into his drawings just as if it were a circulating oil system, water system or electrical system. There are slight changes required in the field sometimes to be sure, but as a result of these efforts his systems are uniformly better than those applied in the field by a mill builders' erection supervisor with little more than a list of valve sizes to guide him. I believe the exclusion of grease systems from engineering design by the mill builder is merely the continuation of an old practice that began when grease systems were comparatively new. The more complete design of the grease system into the mill builder's drawings will eventually be standard practice, I believe. We are anxious to make these layouts for him and cooperate with him in any way in order to get the best possible systems into the users' plants.

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Coke and By-Products in 1953

By I. E. MADSEN

. . . . data and material obtained from Mineral Market Reports M.M.S. No. 2317, August 1954; M.M.S. No. 2330, September 1954; and M.M.S. No. 2341, November 9, 1954 . . . .

▲ PRODUCTION of oven and beehive coke, excluding breeze, in 1953 as reported to the Bureau of Mines, United States Dept. of the Interior, totaled 78,836,857 net tons, a gain of 16 per cent over 1952, but nearly half a million tons short of the record output of 1951. The oven-coke segment of the industry started the year with a high production rate which was sustained through the second and most of the third quarters. In September, the high rate started to decline and at the end of the year slot-type coke ovens were operating at only 85 per cent of capacity. The slackening in steel production in the latter months of 1953 caused blast furnaces to reduce their operating rates which in turn reduced coke requirements. In spite of the decline in by-product coke-oven operations in the last quarter, production from this source for the year was the highest on record. The output of 73,593,528 tons of oven coke, excluding breeze, was about 9,700,000 tons higher than the 1952 total, which was affected by strikes and about 1,600,000 above the previous maximum of 1951.

The recession in steel production adversely affected beehive output and a large number of beehive plants closed in 1953. Production of beehive coke averaged more than half a million tons per month during the first half of the year, but dropped steadily in the last half. The average daily production of beehive coke in December was only one-half of the March rate. Expansion in slot-type carbonizing capacity also was an important factor in the sharp decline in beehive production.

There was, in general, sufficient coke to satisfy all essential requirements in the United States in 1953. In a few instances, particularly during the first part of the year, local shortages developed and it became necessary to ship in coke from distant sources. Most of the deficit areas added new coke-oven capacity and brought production more in line with demand by the end of the year. Requirements for blast furnace coke increased substantially during the year, and a greater proportion of the coke supply was used for smelting iron ore than ever before. Requirements of foundry coke remained about the same as in the previous year, but requirements of coke for manufacturing water gas and residential heating decreased. According to reports from producing companies, 89 per cent of all coke shipped was destined to blast furnace plants, 4 per cent to iron foundries, 2 per cent to producer-gas and water-gas plants, 3 per cent to miscellaneous industrial plants (nonferrous smelting, chemical processing, etc.), and 2 per cent for residential heating.

The annual coke capacity of slot-type ovens increased about 1,800,000 tons during 1953 and reached 78,258,000 tons. This gain was due to the completion of the largest number of new ovens (1027) for a single year since 1918. However, because a major part of the new ovens were replacements rather than additions to existing plants, the industry only gained 381 ovens which raised the total in existence at the end of the year to 15,989. On April 9, 1953, the Office of Defense Mobilization amended expansion-goal No. 4 on oven coke. This goal, announced and approved on December 5, 1951, called for an annual coke capacity of slot-type ovens of 84,000,000 net tons to be attained by December 31, 1953. The goal as amended raised the proposed annual coke capacity to 85,800,000 tons of oven coke, together with complementary facilities for the mining and washing of metallurgical-grade coal required for a balanced operation of this new oven-coke capacity to be completed by January 1, 1955. The annual coke capacity on January 1, 1950 (73,700,000 tons) was used as the base period for estimating future capacity. In the four full years following that date, capacity increased 4,600,000 tons. Capacity of ovens under construction on December 31, 1953, totaled 4,200,000 tons. It appeared that the goal of 85,800,000 tons could not be reached on schedule because of the probable deterioration and failure of old ovens during 1954.

Prices on coke and coal chemicals which had been under regulatory ceilings (Supplementary Regulation 13 of the General Ceiling Price Regulation) since March 16, 1951 were decontrolled by the Office of Price Stabilization on February 18, 1953. The removal of ceilings has little immediate effect on coke prices. The prices published weekly in various trade journals on oven-

foundry coke showed no material changes throughout the year. Price data submitted to the Bureau of Mines by the producers on their commercial sales of coke showed minor changes with blast furnace grade, foundry grade and domestic sizes increasing slightly, while prices on sales for miscellaneous industrial purposes (other industrial) declined. Although prices on most of the coal chemicals advanced slightly, prices on pure benzene increased sharply. Spot prices quoted in trade journals showed that coke-oven pure benzene increased from $0.34 per gallon to $0.41 during the year.

Production of the primary coal-chemical materials and derivatives at coke ovens followed, in general, the increase in coke output. Increases ranging from 16 per cent for gas to 19 per cent for crude light oil were registered by the primary products. The increases in production of derivatives, influenced by demand, fluctuated widely and were as follows: benzene, 15 per cent; toluene, 18 per cent; xylene, 23 per cent; crude naphthalene, 6 per cent; refined pyridine, 4 per cent; ammonium sulphate, 18 per cent; and ammonia liquor, 13 per cent.

Expansion in productive capacity, imports, and a drop in requirements caused some significant change in market conditions of some of the important coal chemicals in 1953. Imports of ammonium sulphate (523,858 tons) were the highest on record in 1953, and were more than half of the production of coke-oven sulphate in the United States. About two-thirds of this foreign material originated in European countries and entered the United States through Eastern ports. European sulphate was offered for sale around Eastern Seaboard ports for about $44 per ton and was delivered to points in the Southeastern part of the United States at lower prices than domestically produced coke-oven sulphate. Sales of coke-oven sulphate lagged far behind production during the summer and fall, and stocks at producing plants reached an all-time high in November. Stocks declined slightly in December as sales increased sharply following price cuts.

The rapid expansion in naphthalene-producing capacity beginning with the 1950 defense program began to show its effect on the market early in 1953. Demand started the year at a slow pace and a six-month strike at a large naphthalene-consuming plant added to the sluggishness of the market. In addition, 41,668 tons of crude naphthalene was imported, mainly from European countries, and sold at port of entry for a price of approximately $0.035 per pound compared with a price of $0.0675 for domestically produced material. The slackened demand coupled with large imports resulted in a temporary oversupply and the first price cut was made in domestic material since 1950. Benzene, one of the most essential chemicals for civilian and military goods, started the year in short supply and ended in a balanced position. Benzene was used principally in the manufacture of styrene, phenol, and aniline which are the intermediate products required to make synthetic rub-

TABLE I

Statistical Trends of the Coke Industry in the United States

	1937	1950	1951	1952	1953
Production:					
Oven coke, net tons	49,210,748	66,890,618	71,987,172	63,850,115	73,593,528
Beehive coke, net tons	3,164,721	5,827,420	7,343,530	4,403,994	5,243,329
Total, net tons	52,375,469	72,718,038	79,330,702	68,254,109	78,836,857
Per cent oven coke	94.0	91.8	90.7	93.5	93.4
Stocks of coke, end of year, net tons	2,595,287	1,110,714	1,482,972	1,901,657	2,679,708
Exports, all coke, net tons	526,683	397,846	1,026,730	792,072	520,252
Imports, all coke, net tons	286,364	437,585	161,639	312,519	157,318
Indicated consumption, all coke, net tons	51,271,929	73,416,519	78,093,353	67,355,871	77,695,872
Disposal, all coke sold or used:					
Furnace coke, net tons	36,751,969	60,918,549	67,440,987	58,182,747	69,728,500
Foundry coke, net tons	2,038,822	3,523,396	3,805,686	3,102,446	3,040,971
Other industrial coke (including producer and water gas), net tons	4,597,894	6,366,497	5,603,262	4,648,077	4,006,560
Domestic coke, net tons	8,107,518	2,565,176	2,087,934	1,932,369	1,467,962
Carbonizing equipment:					
By-product ovens in existence, end of year	12,718	14,982	15,319	15,608	15,989
Beehive ovens in existence, end of year	12,194	17,708	20,458	17,551	15,092
By-product ovens under construction, end of year	259	706	398	1,075	779
Cost of coal charged, oven-coke plants average per ton	$3.74	$8.67	$8.94	$9.23	$9.24
Prices of coke:					
Average realization on oven coke sold (merchant sales):					
Furnace coke	$4.34	$14.31	$15.64	$16.29	$16.37
Foundry coke	$8.47	$20.05	$22.19	$22.49	$23.87
Other industrial coke (including water gas)	$6.08	$14.10	$14.44	$14.10	$14.00
Domestic coke	$6.53	$13.60	$14.45	$14.75	$15.25
Yield of by-products per ton of coal charged:					
Tar, gal	8.67	7.79	7.78	7.74	7.90
Ammonium sulphate or equivalent, lb	21.84	19.89	19.82	19.92	20.09
Crude light oil, gal	2.86	2.81	2.83	2.79	2.90
Surplus gas sold or used, M cu ft	6.66	6.36	6.38	6.35	6.41
Average gross receipts for by-products, per ton of coke produced:					
Tar sold and used (exclusive of amount used in refining and topping)	$0.502	$0.691	$0.757	$0.774	$0.783
Ammonia and its compounds	$0.326	$0.468	$0.501	$0.556	$0.536
Crude light oil and its derivatives (including naphthalene)	$0.435	$0.871	$1.179	$1.149	$1.247
Surplus gas sold or used	$1.483	$1.977	$1.921	$1.921	$2.005
Total coal-chemical materials (including breeze)	$2.974	$4.508	$4.927	$4.98	$5.19

TABLE II

Salient Statistics of the Coke Industry in the United States in 1953

		By-product	Beehive ovens	Total
Coke produced — At merchant plants	net tons	①	①	10,965,352
At furnace plants	net tons	①	①	62,628,372
Total	net tons	73,593,528	5,243,329	78,836,857
Screenings or breeze produced	net tons	5,253,487	83,456	5,336,943
Coal charged into ovens	net tons	104,922,927	8,226,097	113,149,024
Average value of coal per ton		$9.24	$6.36	$9.03
Average yield in per cent of total coal charged —				
Coke		70.14	63.74	69.68
Breeze (at plants actually recovering)		5.02	2.87	4.96
Ovens — In existence January 1		15,608	17,551	33,159
In existence December 31		15,989	15,092	31,081
Dismantled during year		646	2,564	3,210
In course of construction December 31		779	22	801
Annual coke capacity December 31	net tons	78,258,000	10,072,700	88,330,700
Coke used by producer — In blast furnaces	net tons	48,960,723	392,268	49,352,991
In foundries	net tons	119,271	.....	119,271
To make producer gas	net tons	421,272	.....	421,272
To make water gas	net tons	1,055,889	.....	1,055,889
For other purposes	net tons	305,237	87	305,324
Coke sold — To financially affiliated companies —				
For blast furnace use	net tons	10,610,546	1,615,553	12,226,099
For foundry use	net tons	58,682	.....	58,682
For manufacture of water gas	net tons	196,184	.....	196,184
For other purposes	net tons	154,701	.....	154,701
To other consumers —				
For blast furnace use	net tons	5,331,887	2,817,523	8,149,410
For foundry use	net tons	2,795,312	67,706	2,863,018
For manufacture of water gas	net tons	161,559	57,447	219,006
For other industrial use	net tons	1,357,262	296,922	1,654,184
For domestic use	net tons	1,459,420	8,542	1,467,962
Disposal of screenings or breeze —				
Used by producer — For steam	net tons	2,911,918	.....	2,911,918
To make producer or water gas	net tons	24,455	.....	24,455
For other purposes	net tons	908,228	13	908,241
Sold	net tons	1,346,976	82,027	1,429,003
Average receipts per ton sold (merchant sales)				
Furnace coke		$16.37	$14.68	$15.79
Foundry coke		$23.87	$15.64	$23.68
Water-gas coke		$16.84	$15.13	$16.39
Other industrial coke		$13.35	$15.27	$13.70
Domestic coke		$15.25	$13.61	$15.24
Screenings or breeze		$ 5.27	$ 3.69	$ 5.18
Stocks on December 31, 1952:				
Foundry coke	net tons	1,992,469	9,044	2,001,513
Foundry coke	net tons	39,202	2,504	41,706
Domestic and other coke	net tons	634,815	1,674	636,489
Screenings or breeze	net tons	857,651	350	858,001
Exports	net tons	①	①	520,252
Imports	net tons	①	①	157,318
Indicated consumption	net tons	①	①	77,695,872
By-products produced — Tar	gal	828,728,761	.....	828,728,761
Ammonium sulphate or equivalent	lb	2,091,032,132	.....	2,091,032,132
Gas	M cu ft	1,069,140,519	.....	1,069,140,519
Burned in coking process	per cent	35.00	.....	35.00
Surplus sold or used	per cent	62.94	.....	62.94
Wasted	per cent	2.06	.....	2.06
Crude light oil	gal	295,725,435	.....	295,725,435
Yield of by-products per ton of coal —				
Tar	gal	7.90	.....	7.90
Ammonium sulphate or equivalent	lb	20.09	.....	20.09
Gas	M cu ft	10.19	.....	10.19
Crude light oil	gal	2.90	.....	2.90
Coal used per ton of coke	tons	1.43	1.57	1.44
Value of coke at ovens		$1,080,304,156	$76,257,848	$1,156,562,004
Value of screenings or breeze		$22,584,533	$254,157	$22,838,690
Value of by-products sold — Tar sold and used by producer		$59,430,221	.....	$59,430,221
Ammonia (sulphate and liquor)		$39,384,858	.....	$39,384,858
Gas (surplus)		$147,727,356	.....	$147,727,356
Crude light oil and derivatives		$87,442,736	.....	$87,442,736
Other coal-chemical materials②		$25,893,921	.....	$25,893,921
Total value of coke and breeze produced and coal-chemical materials sold and tar used by producer		$1,462,767,781	$76,512,005	$1,539,279,786

① Not separately recorded.

② Naphthalene, tar derivatives, and miscellaneous coal-chemical materials.

ber, plastics, dyes, etc. The large demand for all these materials built up during the Korean emergency carried over in the first part of 1953. The cutback in the Government synthetic rubber program in the latter part of the year reduced requirements of chemical grades of benzene. In order to maintain maximum production of benzene and prevent accumulation of excessive inventories, a few coke producers sold a small

TABLE III

Summary of Coke-Oven Operations in the United States in 1953, by States

State	Oven Coke						
	In existence Dec. 31 (1)		Coal carbonized (net tons)	Yield of coke from coal (per cent)	Coke produced (net tons)	Value of coke at ovens	
	Plants	Ovens				Total	Per ton
Alabama	7	1,408	9,001,423	69.75	6,278,239	$72,501,622	$11.55
California	1	225	1,235,393	60.66	749,381	(2)	(2)
Colorado	1	266	1,406,095	68.78	967,074	(2)	(2)
Illinois	8	934	4,938,018	71.14	3,513,142	59,549,629	16.95
Indiana	5	1,890	12,443,623	71.41	8,886,502	159,966,820	18.00
Maryland	1	622	4,513,777	72.42	3,268,655	(2)	(2)
Massachusetts	1	108	1,206,980	70.39	849,535	(2)	(2)
Michigan	4	621	4,315,969	74.61	3,220,133	49,518,010	15.38
Minnesota	3	241	1,216,232	70.89	862,151	15,362,688	17.82
New Jersey	2	341	1,656,559	70.95	1,175,416	(2)	(2)
New York	5	973	6,624,717	69.28	4,589,609	69,906,676	15.23
Ohio	16	2,513	16,716,709	70.09	11,717,556	163,191,278	13.93
Pennsylvania	14	4,077	27,284,476	68.71	18,747,300	257,075,120	13.71
Tennessee	1	44	300,807	76.90	231,330	(2)	(2)
Texas	2	125	1,043,410	72.06	751,926	(2)	(2)
Utah	2	308	2,208,959	63.73	1,407,818	(2)	(2)
West Virginia	5	731	5,819,008	72.23	4,203,360	49,554,292	11.79
Connecticut, Kentucky, Missouri and Wisconsin	4	562	2,990,772	72.70	2,174,401	37,990,772	17.47
Undistributed	..	.....	.....	.....	.....	145,687,249	15.50
Total 1953	82	15,989	104,922,927	70.14	73,593,528	1,080,304,156	14.68
At merchant plants	24	2,693	15,238,074	71.96	10,965,352	190,459,372	17.37
At furnace plants	58	13,296	89,684,853	69.83	62,628,176	889,844,784	14.21
Total 1952	82	15,608	90,909,495	70.23	63,850,115	925,300,448	14.49

State	Beehive coke						Total	
	Ovens in existence Dec. 31	Coal carbonized (net tons)	Yield of coke from coal (per cent)	Coke produced (net tons)	Value of coke at ovens		Coke produced (net tons)	Value of coke at ovens
					Total	Per ton		
Alabama	.....	.....	.....	.....	.....	.....	6,278,239	$72,501,622
California	.....	.....	.....	.....	.....	.....	749,381	(2)
Colorado	.....	.....	.....	.....	.....	.....	967,074	(2)
Illinois	.....	.....	.....	.....	.....	.....	3,513,142	59,549,629
Indiana	.....	.....	.....	.....	.....	.....	8,886,502	159,966,820
Maryland	.....	.....	.....	.....	.....	.....	3,268,655	(2)
Massachusetts	.....	.....	.....	.....	.....	.....	849,535	(2)
Michigan	.....	.....	.....	.....	.....	.....	3,220,133	49,518,010
Minnesota	.....	.....	.....	.....	.....	.....	862,151	15,362,688
New Jersey	.....	.....	.....	.....	.....	.....	1,175,416	(2)
New York	.....	.....	.....	.....	.....	.....	4,589,609	69,906,676
Ohio	.....	.....	.....	.....	.....	.....	11,717,556	163,191,278
Pennsylvania	12,288	7,212,949	64.27	4,635,513	$66,927,383	$14.44	23,382,813	324,002,503
Tennessee	.....	.....	.....	.....	.....	.....	231,330	(2)
Texas	.....	.....	.....	.....	.....	.....	751,926	(2)
Utah	797	145,607	57.60	83,863	(2)	(2)	1,491,681	(2)
Virginia	848	314,079	59.87	188,033	2,851,499	15.16	188,033	2,851,499
West Virginia	964	440,966	62.00	273,420	3,932,576	14.38	4,476,780	53,486,868
Connecticut, Kentucky, Missouri and Wisconsin	195	112,496	55.56	62,500	(2)	(2)	2,236,901	(2)
Undistributed	.....	.....	.....	.....	2,546,390	17.40	.....	186,224,411
Total 1953	15,092	8,226,097	63.74	5,243,329	76,257,848	14.54	78,836,857	1,156,562,004
Total 1952	17,551	6,911,647	63.72	4,403,994	61,282,146	13.92	68,254,109	986,582,594

(1) Does not include plants retired permanently during year.
(2) Included with "Undistributed" to avoid disclosure of individual company figures.

amount of surplus benzene as motor fuel. Although some benzene was sold in this manner, the price on specification grades of benzene was not reduced.

The increase in oven-coke production and sales of coal chemicals raised the value of all coke-oven products to $1,539,279,786 in 1953. This was about $234,000,000 higher than 1952 and about $418,000,000 above the 1947-49 average.

Additional statistics are covered under their respective topics in the following sections and in Tables I, II, III and IV.

TABLE IV

Coal-chemical materials produced at coke-oven installations in the United States in 1953 (1)

(Exclusive of breeze)

Product		Produced	Sold			On hand Dec. 31
			Quantity	Value		
				Total	Average	
Tar (crude)	gal	828,728,761	448,504,349	$46,070,522	$0.103	33,494,891
Tar derivatives:						
Creosote oil, distillate as such	gal	31,342,703	31,303,068	6,031,444	0.193	2,141,065
Creosote oil, in coal-tar solution	gal	5,983,719	5,640,797	952,312	0.169	42,977
Crude chemical oil	gal	24,812,283	23,690,856	6,147,300	0.259	1,438,607
Phenol	lb	9,656,959	7,355,938	1,115,065	0.152	331,256
Pitch of tar:						
Soft (2)	net tons	579,641	55,528	1,542,260	27.774	8,011
Hard (3)	net tons	301,529				5
Other tar derivatives (4)	net tons	.....	.....	2,061,011	.....	.....
Ammonia:						
Sulphate	lb	1,892,266,104	1,678,791,696	37,726,492	0.022	315,177,365
Liquor (NH_3 content)	lb	49,691,507	39,267,730	1,658,366	0.042	1,615,979
Total	lb	.....	.....	39,384,858	.....	.....
Sulphate equivalent of all forms	lb	2,091,032,132	1,835,862,616	.....	.....	321,641,281
NH_3 equivalent of all forms	lb	522,758,033	458,965,654	.....	.....	80,410,320
Gas:						
Used under boilers, etc.	M cu ft		53,748,111	7,573,669	0.141	.....
Used in steel or allied plants	M cu ft		480,541,315	93,915,597	0.195	.....
Distributed through city mains	M cu ft	(5) 1,069,140,519	99,523,061	39,011,656	0.392	.....
Sold for industrial use	M cu ft		39,144,163	7,226,434	0.185	.....
Total	M cu ft	(5) 1,069,140,519	672,956,650	147,727,356	0.220	.....
Crude light oil	gal	(6) 295,725,435	18,438,408	4,616,477	0.250	4,089,341
Light-oil derivatives:						
Benzol:						
Specification grades (1°, 2° and 90 per cent)	gal	175,579,003	170,456,681	65,767,936	0.386	8,457,413
Other industrial grades	gal	2,013,762	1,948,525	711,163	0.365	123,455
Motor grade	gal	1,160,043	1,150,220	183,687	0.160	25,444
Toluol (all grades)	gal	36,036,486	35,444,655	11,074,653	0.312	1,281,760
Xylol (all grades)	gal	9,928,224	9,759,168	3,118,497	0.320	642,843
Solvent naphtha (crude and refined)	gal	6,285,346	6,068,379	1,522,532	0.251	513,388
Other light oil products	gal	6,097,437	3,257,336	447,791	0.137	306,029
Total	gal	237,100,301	228,084,964	82,826,259	0.363	11,350,332
Intermediate light oil	gal	1,062,422	1,065,467	204,362	0.192	58,687
Naphthalene (crude):						
Solidifying at less than 74 C	lb	56,676,867	52,974,072	1,938,497	0.037	5,310,151
Solidifying at 74 and less than 79 C	lb	56,260,347	38,568,039	2,448,929	0.063	6,438,493
Pyridine:						
Crude bases (dry basis)	gal	550,965	455,561	963,257	2.114	221,554
Refined (2° C)	lb	1,292,415	973,463	1,086,024	1.116	340,776
Picolines	lb	762,470	755,753	280,668	0.371	31,398
Sodium phenolate	gal	2,934,813	2,806,380	624,890	0.223	823,679
Sulphur	lb	8,585,290	8,826,460	119,553	0.014	1,594,960
Other coal-chemical materials (7)	lb	.....	.....	378,349	.....	.....
Value of all coal-chemical materials sold		.....	.....	$346,519,393	.....	.....

(1) Includes products of tar distillation conducted by coke-oven operators under same corporate name. (2) Water softening point less than 110 F. Includes some medium pitch-of-tar reported by two producers. (3) Water softening point above 160 F. Sales and value included with soft pitch-of-tar to avoid disclosure of individual company figures. (4) Cresols, cresylic acid, pitch coke, road tar, tar paint, and topped or refined tar. (5) Includes gas used for heating ovens and gas wasted. (6) 278,905,871 gallons refined by coke-oven operators to make derived products shown. (7) Ammonium thiocyanate and holder oil.

PRODUCTION OF COKE

Average daily production of by-product coke was 201,600 tons in 1953 compared with 174,500 tons per day in 1952. Average daily production from beehive operations was 14,400 tons in 1953 compared with 12,000 in 1952. This increase reflected the increased number of ovens in operation in the case of the by-product coke and also the steady operations throughout the year. The leading states in the order of their importance in the production of by-product coke were Pennsylvania, Ohio, Indiana, Alabama and New York. Combined, these states produced about 46,805,000 tons or 63.7 per cent of national production of by-product coke. This compared with 66.5 per cent for the year 1952. The leading producer of beehive coke was Pennsylvania with 4,635,313 tons or 88.6 per cent of the total. In 1952, Pennsylvania produced 3,750,606 tons and in 1951 Pennsylvania produced 6,396,480 tons. The strong and steady demand in 1953 had thus through

most of the year kept alive and in operation some of the beehive units which would have been down under 1952 conditions. The number of beehive ovens in operation in Pennsylvania in 1953 on December 31 totaled 12,288 compared with 14,589 in 1952. Pennsylvania was the leading producer of all coke produced with a total of 23,382,813 tons or 29.6 per cent of the total. This is an increase over the 27.7 per cent figure which Pennsylvania produced in 1952, and almost back to the 29.8 per cent share which Pennsylvania had in 1951.

NUMBER AND CAPACITY OF OVENS

There were a total of 15,989 by-product ovens in existence at the end of 1953 with a total annual capacity of 78,258,000 tons. This is a slight increase over the 15,608 by-product ovens in operation at the end of 1952 which had an annual capacity of 76,428,000 tons. In 1953, 1027 by-product ovens, capacity 5,341,500 tons, were completed, 646 slot ovens were dismantled and at the end of the year, 779 ovens were under construction with an annual capacity of 4,213,200 tons. The largest number of new ovens were located in Pennsylvania where 429 by-product units were completed with an annual capacity of 2,291,200 tons. Ohio was second and 178 new ovens with an annual capacity of 939,200 tons were completed during 1953. Maryland was third with 126 new slot type ovens, annual capacity 562,000 tons. The largest number of ovens abandoned was in Pennsylvania with 252, and the second largest number abandoned was 96 in Massachusetts.

Beehive ovens in existence at the end of 1953 totaled 15,092 compared with 17,551 at the end of the previous year. These had an annual capacity of 10,072,700 tons compared with 12,004,800 tons the previous year. There were 105 beehive ovens rebuilt in 1953 compared with 480 in 1952. There were 22 ovens under construction at the end of the year. The number abandoned at the end of the year totaled 2564 of which 2406 were in Pennsylvania. Of the total beehive ovens, 13,097 with an annual capacity of 8,886,800 tons were in operating condition at the end of the year and 1995 with an annual capacity of 1,185,900 tons were not in operating condition at the end of the year.

Because of the rapid deterioration of some of the older oven units, the oven construction program could not meet the target set by the ODM of 85,800,000 tons by the end of 1953 and this has been set back to January 1, 1955. One practical factor in this delay is also that although steel demand was very strong throughout most of 1953, it was evident that this would not continue into 1954, thus releasing construction pressure. The better supply situation was reflected in the drop in imports of coke which totaled 157,318 tons in 1953 compared with 312,519 tons in 1952. Exports of coke in 1953 dropped to 520,252 tons from the figure of 792,072 tons the previous year.

COAL CHARGED INTO COKE OVENS

In 1953, 113,149,024 tons of coal were charged into coke ovens. Of this, 104,922,927 tons with a value of $969,308,368 were charged into by-product ovens and 8,226,097 tons with a value of $52,283,334 or $6.36 a ton were charged into beehive ovens. Included in the by-product oven charge are 274,597 tons of anthracite valued at $2,347,801 or $8.55 a ton. The cost of coal (1.43 tons) needed to make one ton of by-product coke was $13.17 a ton in 1953 compared with $13.14 a ton in 1952. The cost of coal (1.57 tons) needed to make one ton of beehive coke was $9.97 a ton in 1953 or $9.24 a ton compared with $9.82 a ton in 1952. The leading states in the mining of coking coal were in the order of their importance: West Virginia, Pennsylvania, Kentucky and Alabama who produced 37,304,493, 37,249,577, 13,048,148 and 8,289,521 tons of coal for by-product ovens.

COKE USAGE

Blast furnaces used a total of 69,728,500 tons of coke or 88.5 per cent of the 78,836,857 tons produced. This is appreciably higher than the 57,969,044 tons used by blast furnaces in 1952. Increase in usage was due to the higher rate of steel production. Coke used per net ton of pig iron and ferroalloys in 1953 dropped to 1834.9 lb compared with 1865.4 lb in 1952. Since the yield of coke from coal was 69.7 per cent, 2632.6 lb of coking coal were used per net ton of pig iron and ferroalloys. Total sales of by-product and beehive coke to other than affiliated companies for blast furnace use was 8,149,410 tons.

The volume of coke delivered to iron foundries declined slightly from the 1952 total and represented 4 per cent of the total coke disposal during the year. The use of coke for manufacturing water gas continued to decline in 1953. In the 1947-49 period, the quantity of coke used to make producer gas and water gas averaged 4,600,000 tons a year. In 1953, this market had shrunk to 1,900,000 tons or 2 per cent of total coke consumption. The quantity of coke used in various industrial applications, classified as "other industrial," decreased slightly from 1952 and totaled about 2,100,000 tons which was 3 per cent of the total. The market for coke for residential heating declined 464,000 tons to 1,500,000 tons in 1953.

STOCKS OF COKE AND COKING COAL

From the reports of the by-product coking plants, total stocks at the end of 1953 of furnace and foundry coke were 2,031,671 tons. Domestic and other coke stocks totaled 634,815 tons. Stocks at beehive plant totaled 13,222 tons. Thus total stocks of all coke on hand totaled 2,679,708 tons compared with 1,901,657 tons at the end of 1952. Stocks of coke breeze at by-product plants totaled 857,651 tons and at beehive coke plants totaled 350 tons. This is somewhat greater than the 756,683 tons on hand at the end of the previous year. Coal stocks remained fairly uniform throughout the year. The inventory of bituminous coal started at 13,400,118 tons in January, dropped to a low of 13,220,760 tons in July, and then gradually increased to 16,485,527 tons at the end of the year. Anthracite stock at oven coke plants at the end of the year totaled 79,381 tons.

GROSS VALUE AND YIELD OF BY-PRODUCTS

Total gross value of by-products sold in 1952, exclusive of the value of the tar used by the producer, and exclusive of the value of the coke breeze produced,

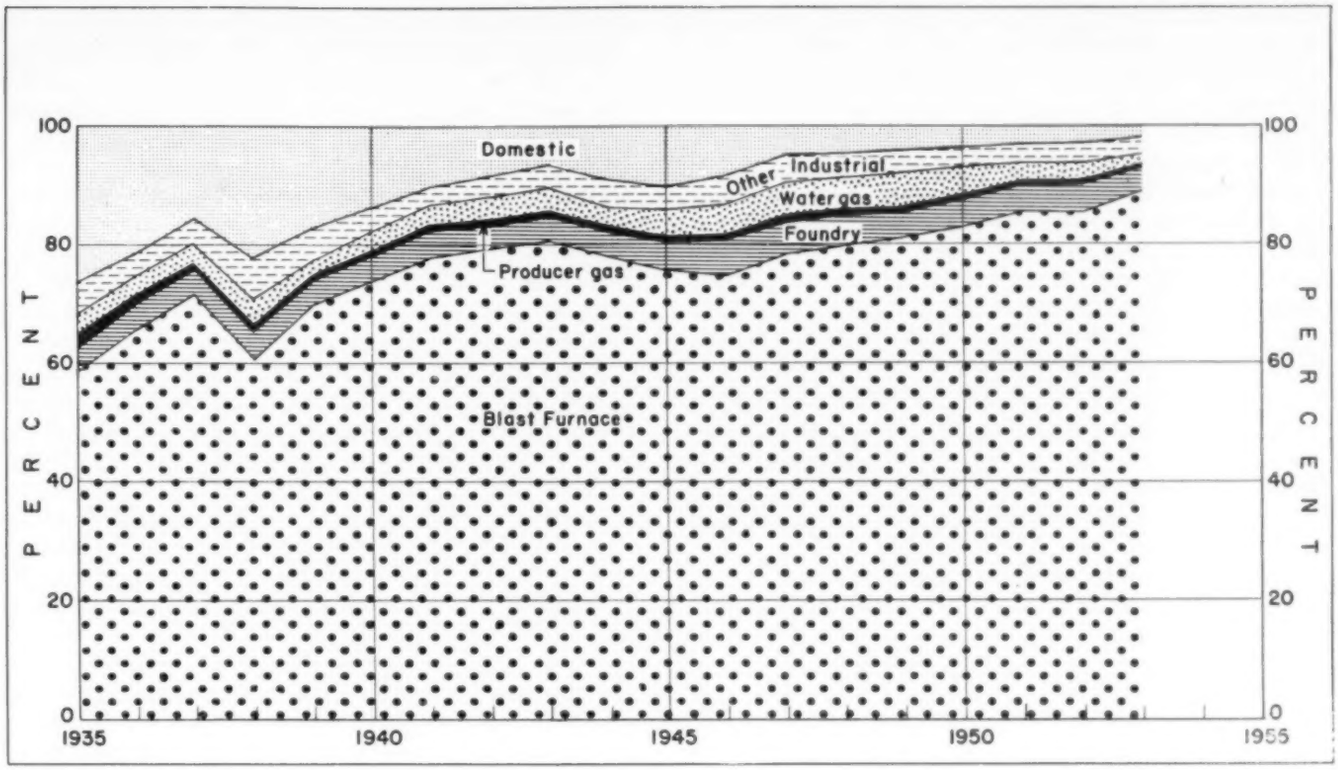

Figure 1 — Chart shows percentage distribution of oven and beehive coke, by principal uses, 1935 - 53 (exclusive of breeze).

totaled $346,519,393 or 29.9 per cent of the $1,156,562,-004, the gross value of all the by-product and beehive coke produced. The average value of coke, coke breeze and coal chemical materials was $19.87 per ton of by-product coke produced. This consists of $14.68 for the coke and $5.19 for the coal chemical materials and breeze. The cost of coal per ton of by-product coke was $13.17. The cost of coal per ton of beehive coke was $9.97 and the value of the beehive coke was $14.54 per ton. In 1953, the average yield of the primary coke products was slightly greater than in 1952, as the average yield of tar increased from 7.74 to 7.90 gal per ton of coal; the average yield of ammonium sulphate or equivalent increased from 19.92 to 20.09 lb per ton; the average yield of crude light oil increased from 2.79 to 2.90 gal per ton and the average yield for gas increased from 10.15 to 10.19 M cu ft per ton. These increases reflect the installation of the more modern equipment and coking practices.

DISTRIBUTION OF OVEN AND BEEHIVE COKE

The volume of coke and breeze distributed in 1953 was the second largest on record exceeding the 1952 figure by 10,700,000 tons (15 per cent) but was short 939,600,000 tons of the peak of 1951. The high production and consumption rates on coke and breeze that prevailed in the latter months of 1952 carried over in the early months of 1953. Production continued at a high level in the second quarter, began to slip in the third, and dropped sharply in the last quarter. This recession in production was reflected in the movement of coke. According to data published by the Association of American Railroads, coke carloadings, originating on Class I railroads, dropped from an average of 59,576 cars per month during the first 10 months to 48,996 in November and fell further to 47,435 in December which was approximately 20,000 cars below those of the comparable month of 1952. Although only about one-third of the total coke production leaves the producing sites, coke carloadings are a fairly good indicator of industrial activity.

The iron and steel industry uses the bulk of the coke produced in the United States and movement of coke follows closely the activity in this industry. The slackening in steel production in the latter months of 1953 caused blast furnaces to reduce their operating rates which in turn reduced coke requirements. This development caused shipments of blast-furnace coke, which averaged about 6,000,000 tons per month during the first three quarters, to drop to 5,500,000 tons per month in the last quarter. In spite of the substantial reduction in movement of blast-furnace coke in the latter months of 1953, the total quantity destined to blast-furnace installations for the year was the largest on record (69,728,500 tons) or 89 per cent of the coke, excluding breeze, distributed by producers.

There has been a tendency in recent years, particularly in the iron and steel industry, to integrate more closely the coke ovens, blast furnaces, and steel rolling and fabricating mills to avoid long hauls on the raw materials required in steelmaking. This tendency, however, has not progressed to the point where all large consumers of coke are self sufficient, hence interstate shipments represent considerable tonnages. Also there are hundreds of small industrial plants scattered in all parts of the United States where individual requirements are not large, but coke is essential in their operations and, in the aggregate, these represent substantial tonnages.

Coke requirements, principally in the Cleveland and Youngstown districts, were greater than production in

Ohio in 1953 and 27 per cent of the total consumption in this State was obtained from neighboring states. Ohio coke consumers obtained coke from 16 states with 79 per cent originating in Pennsylvania and West Virginia. Illinois, which received over 3,000,000 tons or half of its total requirements from 13 other states, ranked second in quantity of out-of-state coke consumed. Most of the coke entering Illinois from other states was blast-furnace grade used around Chicago where production of metallurgical coke was insufficient to meet demand. Shipments of out-of-state coke to New York totaled over 800,000 tons and over 500,000 tons entered Pennsylvania.

As a rule, most of the coke produced in a state is used within that state. Pennsylvania, the leading coke-producing state, led in interstate movement of coke sending nearly 3,000,000 tons across its borders with about four-fifths of the total destined to Ohio and New York. West Virginia sent almost 2,000,000 tons or 44 per cent of its production to 15 other states and two foreign countries with 72 per cent going to Ohio. Indiana and Kentucky shipped almost as much as West Virginia and sent 1,900,000 tons across state lines with Illinois the recipient of 1,600,000 tons or 81 per cent of the total leaving these states. Ohio, although using almost 4,000,000 tons of coke from other states, shipped over a million tons of its own coke to other states. Alabama had the widest distribution sending coke to 31 other states and 6 foreign countries. Most of the Alabama coke was of foundry grade. Other states that shipped substantial tonnages (over 700,000 tons) to other states were Michigan, Wisconsin, New York and New Jersey.

CONSUMPTION BY STATES

Although coke was produced in less than half of the states in 1953, every state, the District of Columbia, and 10 foreign countries used some coke either for industrial purposes or for residential heating. The quantity of coke consumed in each state varied widely depending on the degree of industrialization and types of industries operating therein. The heavy industries (iron and steel) are the largest users of coke and consumption in the United States, particularly in the past decade, has followed closely the rise and fall of pig-iron production. Pennsylvania, the perennial leader among the iron-producing states, lead in coke consumption with 27 per cent of the large coke and 23 per cent of the breeze distributed in 1953. Ohio retained second place with 19 per cent, followed by Indiana, Illinois, Alabama, and New York. These six states used 77 per cent of total coke shipments and 66 per cent of the breeze. Prior to World War II when shipments of "domestic" coke amounted to 20 per cent of the total movement, New York ranked third. However, the decrease in tonnage of coke used for residential heating and for manufacturing water gas was not offset by the gain in blast-furnace usage and New York dropped to sixth place.

Coke for blast furnace use was delivered to 18 states in 1953. Pennsylvania with 30 per cent and Ohio with 20 per cent accounted for one-half of the blast furnace coke consumed in the United States. Illinois and Indiana, principally because of the tremendous capacity of blast furnaces in the Chicago area, together used 18 per cent of the United States total. The greatest tonnage increases in consumption of blast furnace coke in the past several years occurred in Pennsylvania, Ohio and Indiana where additional blast furnace capacity had been completed.

Foundry coke was distributed to all but two states and the District of Columbia in 1953 with Michigan alone receiving 23 per cent. The large quantity of coke delivered to foundries in Michigan was primarily to melt iron and scrap for castings required by the automobile manufacturing plants.

Coke for making producer gas was used in eight states and 18 states required coke for manufacturing water gas. West Virginia alone used 54 per cent of the total quantity of coke used in making water gas in the United States in 1953. The tonnage of water-gas coke dropped 25 per cent from 1952 with the largest decreases occurring in Virginia, Ohio, Connecticut, Massachusetts and New York. In Ohio and Virginia, natural gas was substituted for coke as a starting raw material in the manufacture of ammonia. In Connecticut, Massachusetts and New York, gas utilities converted to the distribution of natural gas instead of manufactured gas. Coke classified as "other industrial" embraces a wide variety of applications (chemical processing, nonferrous smelting, lime burning, mineral wool manufacture, etc.) and was destined to all but two states with consumers in Ohio, Pennsylvania and Michigan receiving 37 per cent of the total.

Coke for residential heating was distributed to 38 states but the total movement was 24 per cent less than in 1952 and was only about one-sixth as large as the 1940 total.

BREEZE

The movement of breeze is generally more restricted than large coke, although new uses have been developed in recent years and substantial tonnages are now shipped great distances. For example, breeze required in the electrochemical industry particularly for the manufacture of elemental phosphorus, in Montana and Idaho was obtained from points as far away as Ohio. Alabama supplied most of the breeze used in Florida and Tennessee for similar operations. Although precise data on the end-use of breeze in each state are not available, statistics compiled from annual reports showed that 60 per cent was used for steam raising, 39 per cent for other industrial purposes, and 1 per cent for making producer gas or water gas. Production of coke breeze in the United States in 1953 totaled 5,336,943 tons compared with 4,639,369 tons in 1952. Production of breeze in beehive plants in 1953 is included in this total to the amount of 83,456 tons.

EFFECT OF NATURAL GAS

Marketed production of natural gas in the United States increased 383,000,000,000 cu ft in 1953 to 8,397,000,000,000 cu ft. This was a smaller gain than the 556,000,000,000 recorded in 1952. Texas, Louisiana, Oklahoma and New Mexico accounted for most of the gains.

Natural gas was consumed in 42 states and the Dis-

trict of Columbia. Rhode Island received natural gas for the first time in 1953. California reported the largest gain in consumption of any state for the year. Consumption in the United States totaled 7,979,000,000,000 cu ft. The quantities used by various classes of consumers in 1953 and the percentage change compared with 1952 were as follows: residential, 1,686,000,000,000 cu ft, +4 per cent; commercial, 531,000,000,000, +3 per cent; field, 1,471,000,000,000, —1 per cent; petroleum refineries, 589,000,000,000, +4 per cent; other industrial, + 8 per cent.

The gross addition of natural gas to underground storage of 405,000,000,000 cu ft was only slightly greater than in 1952. Withdrawals from underground storage of 247,000,000,000 cu ft were 11 per cent greater than the year previous.

The average value of natural gas at the wellhead in 1953 was 9.2 cents per thousand cu ft. This was an increase of 1.4 cents per thousand cu ft over 1952 and the largest rise yet reported in one year. The total value of marketed production at the wellhead was $775,000,000.

The average value of natural gas at point of consumption in 1953 was 35.5 cents per thousand cu ft, 2.3 cents higher than in 1952.

Interstate shipments and exports of natural gas increased 11 per cent in 1953 and constituted 50 per cent of marketed production.

The number of residential consumers increased by 1,600,000 to 24,200,000. The largest single gain was made in Massachusetts where conversions were made from manufactured gas.

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. . . . three papers presented at this meeting, held March 10, 11, 1954, are of particular interest to the steel industry . . . .

SELLING SAFETY

By WALTER L. JONES, JR.
Safety Engineer
Alan Wood Steel Co.
Conshohocken, Pa.

▲ WHERE there is a lack of cooperation between the safety department and the operating department, a good workable safety program does not exist. In some organizations only the safety department has been responsible for safety and the operating departments unconcerned, resulting in a poor accident prevention program. This also holds true in cases where the safety department is not practical and tries to put through rules and regulations which are not workable, failing to use a realistic approach to the problem.

When the safety department and the operating departments cooperate, invariably a good accident experience is obtained. All of us are familiar with the key man of the safety program—the foreman—the fellow who is responsible for costs, production, labor relations, health, welfare and the safety of all of the men under his supervision. In this matter of cooperation, it is up to your department to help this man of many jobs, to guide him and to supply him with the wherewithal in order that he can get his men to be more safety conscious.

Industry spends a large amount of money to equip their sales force with the necessary training, literature and advertising. They do this in order that their salesmen will have an easier task of selling their product. Through these means, their potential customers will already be aware of the added advantages their products offer over their competitors even before the salesman knocks on the prospect's door.

With such an important item as safety to sell, is it not feasible for a company's safety department to supply information and advertise safety to their employees? In other words, lay the necessary ground work for the foremen in order that he will be equipped to do a better job.

At Alan Wood Steel Co. we have initiated the following programs which we feel are doing a good job to advertise the product we are selling—Safety.

1. *Match Program*—A few years ago we installed book matches in our plant cigarette vending machines. Each book match contained a hidden letter on the inside corner of the cover. When the covers were saved, these hidden letters would spell "Safety Shoes," and the employees would turn these covers in and receive a pair of safety shoes free of charge.

A great deal of interest was shown in this campaign, so this year we started a similar one. Safety book matches with tabs on each side which must be torn out in order to get to the matches have been installed in our plant vending machines. Different slogans appear on the back of these tabs, and when the winning slogan, "Safety Galore in '54," is obtained, the employee turns it in and receives a pair of safety shoes free of charge.

In this manner we feel we are promoting the sale of safety shoes and keeping safety in front of the employee every time he strikes a match. These matches will also get into homes, business houses, stores and other places, always getting their safety message across. As a matter of explanation in regard to our slogan, "Safety Galore in '54," we started this program in 1951 with the slogan "Don't be the one in '51," continuing on due to its success to 1952 when we used the slogan "Don't let it be you in '52." In 1953 we used "It won't be me in '53."

2. *Pins*—Observing how men like to collect and wear pins or buttons, we decided to use this advertising place. Last year we ordered and distributed over 2000 buttons. The employee would come to us and ask for them, and a lot are still being worn. This year we are repeating ourselves and giving the pins out with the new slogan.

3. *Signs*—Signs with adhesive backing are placed on trucks, doors, buildings and any other location which would be advantageous. In addition to these signs, National Safety Council posters, vender posters and insurance company posters are put on bulletin boards located in clockhouses.

Figure 1 — Sign at entrance to steel plant from parking lot.

Figure 2 — Signboard outside of main gate.

Figure 3 — Archway at entrance to blast furnace.

Figure 4 — Exterior of Safety Store.

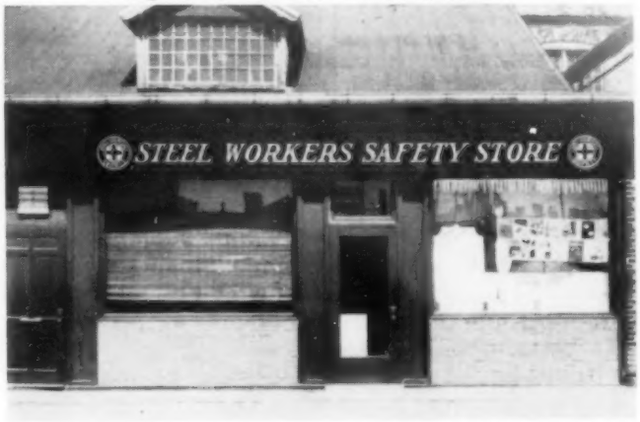


Plate glass mirrors approximately 3 ft by 4 ft in size have a 3 in. etched slogan at the top: "Are you looking at a safe worker?"

Large signs are placed throughout the mills in key spots. (Figures 1, 2 and 3).

In addition to this advertising program to help our foremen we orientate new employees at the Safety Store (Figure 4) and supply the necessary safety equipment. We also give to the new employee large green buttons with an insert for their name explaining to them that this should be worn for a period of two weeks until they get their permanent identification badge. Management and the union have cooperated on this program and orders have been issued that, when a man is observed wearing this green badge, the men are to look out for him and help supervision in guiding him in a safe manner of doing his job. Safety shoes are also sold at cost to the new employee, and he does not leave the store without a pair.

In any safety program, it is essential that codes, safe working procedure and safety rules which are workable be made in cooperation with supervisors. Never have rules or codes that are not workable. We have safety committees consisting of hourly men active throughout the mills, with monthly meetings. An executive committee, consisting of top management, formulates policy and handles final disposition of major items. Safety inspections by the safety department, covering safety, fire and housekeeping conditions, are made periodically.

Pre-employment physical examinations are conducted by a qualified physician to determine physical fitness of the prospective employee. An eye screening test, conducted by a Bausch and Lomb Orthorator, is used to determine visual acuity depth precision and color blindness. Periodic physical examinations are given to operators of mobile equipment.

Safety meetings are conducted by the foremen with their men. The safety department cooperates in this program by supplying necessary literature and attending these meetings.

SAFETY IN OPERATIONS

By C. E. PRITCHARD
Superintendent of Mills
Alan Wood Steel Co.
Conshohocken, Pa.

▲ INDUSTRIAL management appreciates the value of effective programs of accident prevention. The first objective of any program must by necessity entail the fullest voluntary cooperation of every employee of every department.

Of importance, second only to the primary object of saving human life and preventing injury, is the need for safety of the product being processed and the producing machinery itself. All too often these basic fundamentals are treated too lightly, and as a consequence present a definite loss in earning power for the individuals involved. This problem is of paramount importance in the operation of a steel plant due to the

large capital expenditures involved and the tonnages produced.

The safety program of a steel plant touch a great variety of hazards. Its scope of coverage is infinite in that it entails heavy duty machinery, high temperatures, high speeds, all types of conveying and transporting equipment, etc. It is quite probable that the very nature of steel operations, offering such a vast number and variety of conditions, served to influence the steel industry to be one of the early leaders in the field of safety. The steel industry as a whole has developed safety programs to a point where they are accepted as being as functional as the art of steel making itself.

Follow up of any program is imperative to successful operation. Taking pride in the reduction of accidents should be the personal goal of every member of industry, especially those in supervisory capacity.

Experience in the steel industry has indicated the wisdom of building the safety programs around the foreman, as he in his routine duties is closer to the actual work requirements of the unit and generally knows whether the man assigned to the job is capable of doing same in a safe manner.

Supervisory personnel must be constantly alert for hazardous conditions and must take steps to eliminate them as soon as possible. In order to achieve this objective, the supervisor must be tactful as well as forceful.

It might truthfully be stated that the success or failure of any safety program can be influenced by the attitude of the supervisor. The supervisor must first be sold on the issues involved before he can pass them on to his fellow man. Careless or derogatory remarks dropped by a supervisor can nullify the beneficial effects of any safety program. Carefully prepared questions presented either in group meetings or out in the shop will tend to promote active interest on the part of other individuals. Open discussion of prior accidents with operating personnel will promote active interest and will be found to contribute greatly in instituting ways and means for prevention recurrences.

Departmental safety and good housekeeping inspections serve to promote a better understanding of the principles of accident prevention, offer incentives to accelerate safety activities and provide better communications between the respective operating departments. In all cases noted, good housekeeping has been found to be synonymous with safety.

Every supervisor is interested in operations. He can be equally impressed with accident costs, both injury and non-injury, if they are properly presented. To be complete, the non-injury phase must include the cost of repairing damaged machinery, replacement of damaged material and the loss of equivalent tons due to mill delay. The conversion of mill delay time back to equivalent tons or dollar value gives the individual a better mental picture as to the extent of loss incurred and its effect on his own personal economical return.

Supervisors should adopt a fair but firm attitude on all matters pertaining to safety. All members of the industrial team, regardless of their respective position, must have a common understanding as to what safety stands for. It is only by proper training and complete cooperation on the part of all concerned that the mutual benefits to be derived therefrom are fully realized. Written warnings and reprimands are an important part of an enforcement program but must be used judiciously to prove effective. The right or safe way must be repeated over and over again, both by act and discussion until it becomes a habit.

Through observations, investigations and reports, new safety problems are constantly presented. All must be evaluated, some resulting in standards being adopted immediately to cover same, whereas others may be studied more in detail due to extreme costs involved. As might be expected, a relatively small percentage of suggestions presented are not considered feasible and are not pursued further, some become outmoded due to changes in operating conditions.

The steel industry, like many other industries that have assembled a vast number of case histories covering accidents, finds a definite correlation exists, even where the operations outwardly would appear to be unrelated. Statistics prove that certain individuals are more accident prone than others working under similar operating conditions. When a person shows up as being in this category, it cannot be accepted as bad luck alone. Alibis offered by the repeater as to his own responsibilities should be exploded by factual information and actual statistics.

Study of existing records indicates that the same individuals who repeatedly injure themselves also seem to encounter other kinds of difficulties. They have minor sickness absenteeism, report to the dispensary with minor complaints more than the average and very often have trouble getting along with their bosses or fellow employees. Our own personal observations indicate that the most effective measure of benefit to employees of this type appears to be the need for added personal attention paid directly to the individual involved. The fact that someone is following his record more intimately seems to offer some added inducement on his part to strive to do better.

There are two types of accidents—those that cause personal injury and those not involving injury, both are of equal importance from the standpoint of investigation. Too often, only those involving an injury are investigated to any great degree. It is deemed advisable to extend the same consideration to the near-misses, for too often the near-misses of today if left unattended, develop into serious accidents of the future. It behooves every one of us to take the necessary steps to follow through on all types of hazardous conditions and institute the corrective measures to eliminate the contributing causes.

Competitive interest between the different mill operating turns of each department serves as a basis for comparison with each other as well as with the past records of the department. Special emphasis must be given to coverage of equipment located in remote spots and the relative degree of responsibility of each turn regarding the development of conditions which contribute to safety. Caution in the piling of steel slabs, billets and blooms as processed is typical practice for the steel plant personnel, whereas the tendency for the same men to disregard similar precautionary measures when piling blocking lumber is difficult to explain but occa-

Figure 1 — Blooming mill pulpit has shield of bullet-proof glass in front of plate glass window.

Figure 2 — A chain screen on the blooming mill reduces the hazard of flying scale.

sionally experienced. This idiosyncrasy of man only serves to explain more fully the need for follow through in order to affect more complete safety coverage.

Inspection of physical facilities to spot accident breeding hazards will not, alone, prevent accidents. Many of the problems involve the human element. When a man falls off a ladder or a platform, the inspection should not be concluded after examination of the physical aspects of the ladder or platform condition alone. A more thorough check or study will very often reveal that the conditions surounding the location of the accident are satisfactory, but the man involved was not suited for the job intended due to his physical condition, such as being subjected to dizzy spells, unable to climb to high places, etc.

Diligent inspection must be made at all times to insure that safety guards and devices are replaced properly and are in good working condition before operating machinery is started up. Another common sense safety rule is to make certain everyone is in the clear before starting up any given unit. Safety railings serve a very useful purpose, but are only effective when mounted properly and in a good state of repair.

The practice of using red signal lights on stationary cranes is found to be of value for routine maintenance where personnel are not endangered by being bumped by another crane. When conditions demand exposures of this type, it is imperative that additional protective measures be exercised, such as mounting of safety stops, cutting of the electrical current in the proximity of the idle crane, etc.

Standardization of master switch locations in mill speed control pulpits, crane cabs and similar type units, where practical, is considered a justifiable program. In all cases the operators' vision, convenience, comfort and fatigue tendencies are to be taken into consideration. Warning klaxons or sirens are mounted on all cranes where the surrounding noise level precludes the usage of foot-operated gongs.

Operations such as the baling of scrap, where the loose ends of scrap might come in contact with the operator or other personnel's clothing, are met satisfactorily by the installation of a dead-man control switch. In this manner the baler cannot be operated unless the operator's hand is constantly pressing the control button. Any tendency to pull the operator out of position would automatically result in stoppage of the baling operation. Use of diverting guide chutes are also employed in this case to confine the movement of the scrap from the machine to the baler in a safe manner.

Comprehensive studies through the years have shown the need for usage of special grades of glass for protection of operating personnel. Typical applications include such installations as the window lights of the roller's pulpit of blooming and slabbing mills, window lights of soaking pit cranes, window lights of mill cranes, heat shields, safety shields for caustic tanks, etc.

Tempered plate glass lends itself admirably for varied usage throughout the steel plant. It is reported as being four to five times as strong as regular plate glass of the same given thickness. It has a safe maximum working temperature of approximately 550 F. Upon reaching the limit of its mechanical strength, tempered plate glass breaks down into small granular, regular fragments, the edges of which are relatively smooth and rounded, which tend to interlock and remain in the pane of the glass. Its flexibility under a given stress is the same as that of normal plate glass, but it may be flexed from four to five times farther than normal glass before breakage will occur.

Due to the high impact loading imposed on the window lights of a blooming mill roller's pulpit, it is found to be mandatory to provide additional protection for the glass facing the mill stands proper, which normally takes the full force of flying scale as released from the surface of the ingot during the rolling operation. A typical installation of this type entails bullet-proof glass approximately 1⅛ in. thick and tempered plate glass, approximately ¼ in. thick. The bullet-proof glass is generally a laminated plate glass developed for use where special protection is required.

Some mention should be made when discussing steel plant safety programs regarding care of the eyes. This subject has been covered in detail in its many ramifications so it will suffice to say that every effort should be made to provide the necessary eye protection or shielding commensurate with the job to be done.

Experience has shown that the actual workman performing a specific job recognizes the need for proper protection for himself, but quite often fails to consider the exposure of his fellow workman who is adjacent to him at the time. A common complaint in this regard is the welder's flash when using the electric arc or cutting

flame of the acetylene torch. The person affected does not usually encounter any discomforting sensation at the moment of exposure, but rather several hours later. Probably for this reason it is sometimes difficult for the affected person to associate the two conditions with each other. Contrary to the generally accepted impression that exposure to a welder's flash occurs more commonly at night, statistics prove that day time exposure conditions are just as imminent. Workman exposed to sudden intense light, such as that emitted by molten metals or glowing slabs of metal, must be properly shielded to prevent discomfort or possible eye injury.

There is no magic formula for fire protection. It is only satisfactory when it works. Although fire may never happen, you can be ready when it does. To make any program of this type function it is necessary to follow through on a day-by-day routine. Responsibility for adequate standards, training programs and proper dissemination of information rests heavily on supervision. The first step is to analyze the various functions of the operation to ascertain what standards must be set and maintained.

Training of personnel in the proper steps to take to meet actual outbreaks of fire is of prime importance. All persons should be trained in the operation of fire extinguishers. The selection and usage of the different types of extinguishers for the specific type of fire encountered should be carefully explained and workers given the opportunity to use these extinguishers.

The workmen of each sub-department must be guided in their actions during periods of emergency. Experienced group leaders must be allocated known responsibilities of direction in order to avoid conflicting measures being taken by the various fire brigades which might be involved in fighting a fire. Considerable benefits will be derived from planning the limits of coverage expected of each respective fire fighting unit in advance of the actual emergency.

Standardization of fire fighting equipment, such as hoses, nozzles, attachments, extinguishers, extinguisher stations, hose stations, etc., aids materially in familiarizing the average workman with the proper unit to use with the shortest possible delay time. Hose stations and fire extinguisher stations should be strategically located throughout the departments on a planned coverage basis. Painting these locations with some vivid color or combination of colors tends to identify the closest station to the point of need, while also permitting routine observation as to number and condition of units on hand. We have found that, if a suitable section is provided for empties at the fire extinguisher stations, the old problem of picking up empty extinguishers during periods of emergency is held to a minimum.

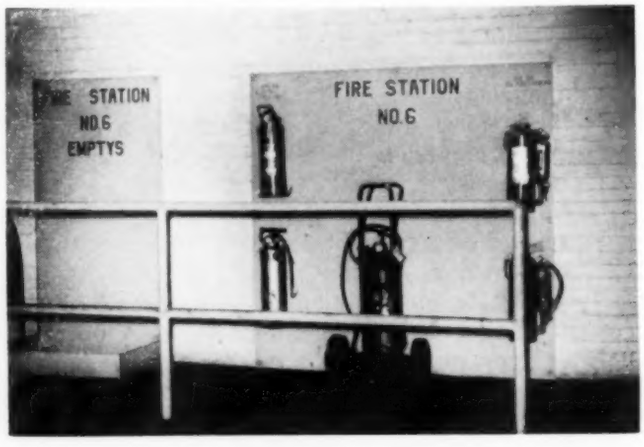
After the plant has been analyzed completely and the necessary measures taken to institute adequate interplant coverage in fire prevention, it is deemed advisable to go one step further in reviewing your overall plans with the local fire departments, which might be called upon for assistance. Group visitations to the plant by local fire department personnel tends to aid them in getting properly oriented with the extent of coverage, strategic location of apparatus, location of fire hydrants, etc. It is also considered advisable to provide a descriptive map of the plant showing areas where flammable materials are stored and possible hazardous situations might be experienced.

Just as important as any of the actual fire-fighting operations is the job of keeping a twenty-four hour watch after the fire has been extinguished. A common error is to disregard this fundamental, especially with small fires, and as a result of this failure, a fire of more serious consequence may develop.

Installation of automatic lubricating systems and devices has provided a means whereby all critical points of operation of producing units can be adequately covered in a safe and efficient manner. Previously it was a question of curtailing production in order to manually lubricate the numerous bearings, gears, sliding surfaces, etc., in a safe manner. With the development of the semi-automatic and automatic lubricating systems of the present time, it has been found possible to install the central control reservoir and pumping unit in a remote spot completely removed from the moving machinery elements themselves, thereby eliminating the personal hazards involved. Good housekeeping has also been made possible due to the unit control over both the amount of lubricant applied and the given cycle or frequency of application. Wastage of lubricants with their attendant unsightly conditions can now be placed under the desired control.

A few examples of these automatic systems would be the vertical edger system of our 30-in. hot strip mill, the mist type lubricating system covering the pedestal drive bearings of the 30-in. hot strip mill, the feed conveyor chain drive spray type system of our hot strip finish department and the oil and grease systems of our 35-in. blooming mill. The vertical edger bearings were formerly hand greased and the gears were coated with a heavy lubricant poured over them from a vantage point above the gears proper. These methods resulted in exposure of the oiler to moving machinery parts, flying scale and intense heat. The present method automatically sprays the same lubricant on the gears as is used on the bearings at the desired frequency without any hazard to personnel. The mist type lubricating system of the mill drive bearings provides adequate lubrication with a vastly improved housekeeping and lubricant saving. The chain drive spray system provides superior lubrication of the moving chain parts without any hazard, the oil reservoir being filled at a

Figure 3 — Fire station in strip mill motor room.



time when the conveyor is inoperative. The oil and grease systems of the blooming mill eliminate the need for personal exposure to the flying scale particles.

Modern design has been employed throughout the recent installation of a continuous cascade type strip pickle line. All acid vapor is drawn from the top of the pickling solution through a series of collector pipes and washed by a water curtain which converts the vapor to the liquid phase. The acidic build up in the condensate is disposed of by pumping to a slag bed located at the open hearth department, contact with the slag tending to neutralize the acid radical of the effluent. Quick acting shower sprays are strategically placed along the continuous pickle line to permit individuals accidently coming in contact with the acid to flood wash the affected part.

SURVEYING FOR SAFETY

By J. B. QUESNEL
Safety Engineer
Bethlehem Steel Co.
Sparrows Point, Md.

▲ SURVEYS of various types have been used with success in industry to help solve problems of production. Surveys, also, can and do help in accident prevention.

Numerous examples of safety surveys could be discussed but, since overhead cranes is a subject familiar to the entire steel industry, let us look at an actual survey as applied to crane runways, approaches, mechanical guarding, housekeeping, and work procedures in connection with crane operation and maintenance, both mechanical and electrical.

Several years ago the safety department at the Sparrows Point plant of Bethlehem Steel Co. called attention to the serious accident potential involved in crane operations and suggested to the management that a study be made of all cranes in the plant. Management agreed and instructed the safety department to conduct a comprehensive study of all factors in connection with crane safety. In accordance with this instruction, a survey was started, conducted by a two-man inspection committee from the safety department. The use of only one inspection team increased considerably the time required for the completion of the project, but had the advantage that the same individuals got the overall picture, and therefore were in a better position to make uniform recommendations than if a number of other personnel had been involved.

The survey involved a thorough inspection of all cranes, runways, work platforms and approaches in the plant. In total, 321 cranes in some 14 departments were covered. In addition, departmental work procedures were studied, representative repair jobs were observed and numerous crane operators and repairmen were interviewed. While survey procedure was altered from time to time in the early stages of the assignment, the following points were finally adopted as being most satisfactory:

1. At the Sparrows Point plant, the electrical repair personnel, as well as the majority of the crane operators, are under the direction of the electrical department. The inspection committee therefore first outlined the program to the electrical superintendent. He, in turn, explained the plan to his general electrical foreman.
2. In order that the items observed during the survey could be accurately recorded and a uniform report submitted to each department, a number of forms, eleven in all, were developed.
3. In selecting departments for inspection, first attention was given to those departments in which, because of special operating conditions or their previous accident record, it appeared most likely that tangible benefits would result from a survey.
4. A meeting was then arranged with the superintendent, the general electrical foreman and the safety supervisor of the department selected. At this time the program was explained and arrangements were made to proceed with the survey.
5. The general electrical foreman was interviewed to determine what work procedures and safety precautions were already in use in the department. This information was recorded.
6. Repairmen were interviewed on the job to determine how familiar they were with departmental work procedure and safety regulations. At this time the program and its purpose was explained. It was emphasized that their help and cooperation were highly essential to the success of the undertaking. Their comments, suggestions or criticisms were recorded.
7. Representative operations, varying in nature, were observed and details of their performance were noted. When crane operators were interviewed individually, on their cranes, during the crane inspection, the committee first notified ground supervision and the crane operator. The operator was then requested to move the crane to a point where it would interfere the least with ground operations and the operation of other cranes. Switches were disengaged and tagged and the out-of-service lights turned on. The crane operator was then interviewed relative to procedures followed by him in the operation of his crane.

Inspection of the crane was then made. Information was listed in detail, giving the exact location of hazards. All conditions were noted, both good and bad. Particular attention was paid to guarding, condition of electrical equipment, obvious structural defects and housekeeping.

An inspection of runways was made, along with work platforms. In instances where safety requirements made additional work platforms desirable or necessary, a note to that effect was prepared and the matter was discussed with supervision. Approaches to cranes and runways were checked to determine if any hazards were present. Photographs were taken where conditions were of particular interest for study.

During the period of the survey, the mechanical department also conducted a building inspection, which included a structural examination of all cranes and associated facilities. Copies of their reports were for-

warded to the safety department and proved to be of considerable technical value to the safety inspection committee. The engineering department also rendered valuable assistance during the course of this survey. In instances where relocation of approaches or modification of runways appeared desirable, a representative of the engineering department consulted with the committee and furnished advice. The engineering department also assisted by preparing drawings and estimates.

This concluded field observations. The information was then entered on the forms previously referred to. A summary of findings and recommendations in triplicate was assembled in loose leaf binders, a separate binder being prepared covering each department.

As each department was completed, one copy was forwarded to the general manager who, after review, returned it with comments to the safety department where it is retained as part of the permanent files. Another copy was given to the superintendent of the electrical department and a third to the superintendent of the department in which the survey was conducted. A meeting was then arranged with the departmental superintendent, safety supervisor, general electrical foreman and members of the inspection committee. The report was reviewed and plans made for the elimination or correction of the hazards found.

The general manager recognized that much of the value of this survey would be lost unless a sound follow-up procedure was instituted. The following procedure was established and put into effect.

1. Blank copies of the specific inspection forms were supplied to the general electrical foreman.
2. Hazardous conditions outlined in the report were recorded on these forms and orders given to make necessary corrections.
3. When the necessary corrections were made the copy was marked accordingly and returned to the repair department. Here, in turn the information was recorded in their permanent copy of the report.
4. Reports were made to the safety department by the individual departments regarding work done in connection with crane and runway hazards. This information was compiled and periodic progress reports submitted to management.

After all cranes had been inspected and the reports analyzed it was evident that there was a lack of uniformity in connection with crane safety appliances, their use, and work procedures. With the approval of the superintendents of the safety and electrical departments, the inspection committee formed what was known as the crane code cimmittee.

This committee was composed of all general electrical foreman, three departmental safety supervisors and the members of the inspection committee, with the general foreman of cranes acting as chairman. The pertinent subjects were discussed in a series of meetings and agreement was reached on recommendations for the adoption of a number of items. No attempt will be made at this time to list the many items discussed.

A number of hazards were noted during the course of the survey, created by the location or type of crane approach, platform or runway. A guide containing recommendations based on the safety code issued by the State Industrial Accident Commission of Maryland and on the findings of the crane inspection committee was formulated. These recommendations applied to both new construction and the modification of existing facilities. As part of the follow up program, it was agreed that a more frequent inspection of cranes and runways by the departments would be advisable.

Much has been said about the physical aspects of crane operation, and the responsibility of management in providing as many safeguards as possible to prevent accidents. The importance of this should by no means be minimized. There is another aspect, however, which came in for considerable attention. The unsafe act of the individual has been the largest contributor to the accidents. Many personal unsafe acts were observed and reported during the course of the survey. The most important of these was the unauthorized use of cranes and runways. After the crane code committee reviewed the unsafe practices noted, recommendations were made relative to the control of persons required to work on or around cranes and runways.

A number of the departments had very satisfactory work procedures, but some were incomplete. The safety department, with the cooperation of the repair personnel, prepared a work procedure which we felt could be used in most part by all departments. A copy of this was included in each department's report.

These general instructions have been supplemented by our job safety analysis program. In this program, specific jobs are studied and procedures are established for their safe performance. This program is a subject in itself. It is enough here to say that job safety analysis is the most important single tool available as far as practical accident prevention is concerned.

The results of the survey contributed in more ways than originally anticipated. One example was in the matter of economy. Accumulations of grease and oil were noted. The committee was not only interested in having it removed, but was concerned with the reasons for its presence. A number of factors entered into this condition, but one in particular contributed to a major degree: lack of care on the part of lubricating personnel. Large quantities of oil were spilled on bridge walkways, and in many cases excess grease was not cleaned up after each job. Broken lubrication lines were also responsible. This situation was discussed and resulted in an improvement in the condition. Proper scheduling provided the necessary time to do the job right, and education of the lubrication personnel was helpful. Not only was a serious hazard and the subsequent time needed for clean up materially reduced, but an economy was effected by reducing the quantity of lubricants used.

Cooperation on the part of operation and maintenance personnel also resulted in better scheduling of repair jobs. This, of course, not only permitted sufficient time for doing minor jobs safely, but, by regular scheduling of minor repair jobs, cranes were kept in good operating condition, precluding those major repairs that often result from neglect.

At the start of the survey, the repairmen appeared somewhat skeptical as to the value of the program. Later, however, when convinced of the thoroughness

of the inspections, and impressed by the idea that it was a sincere effort on the part of the company to do something about their welfare, they were most cooperative. In fact, many helpful suggestions were received from them and put into effect.

Today, in accident prevention work the emphasis is on people—to get more and more people into the act—to get people to want to work safely. To do this we must have everyone on the team taking an active part. Only in this way can we have a successful program.

APPENDIX

RULES GOVERNING CRANE REPAIRMAN

SCHEDULED CRANE REPAIR JOBS

1. Before starting job, notify following, giving details:
   A. Foreman of operations
   B. Crane foreman
   C. Crane foreman of adjacent operation, if crane is operating on a joint runway.

   Note: Before starting work, check with crane operator to be sure that he has been informed.
2. Position crane where it will least interfere with operations. (Consider method of access for repairman.)
3. Disengage both cab and main line switch and place *your* tag on same.
4. Place warning signs on ground beneath crane under repair.
5. If possible, rope off area beneath crane under repairs.
   If more than one crane operates on same runway:
6. Turn on out-of-service lights.
7. Place emergency rail stops and streamers, at sufficient distance, from side or sides of crane exposed to other cranes, to insure safety of workmen. Before placing stops have operator move crane to point where they are to be attached and mark position to insure even installations.
8. If crane must be moved before job is completed, turn off out of service lights and remove *your* tag from switches. Switches shall not be engaged until all men have removed their own tag and all men are accounted for.

EMERGENCY CRANE JOBS OR JOBS OF SHORT DURATION

1. Notify crane operator of work to be done.
2. If work is confined to cab, disengage and tag cab switch.
3. If approach to crane cab is from crane bridge, disengage and tag both main line and cab switch.
4. Turn on out-of-service lights.

AT COMPLETION OF JOB

1. Replace all safety devices such as guards, limit switches, etc., before crane is released for service.
2. Remove all tools, material, equipment and trash from cranes and runways, immediately upon completion of job. (Do not throw.)
3. Turn off out-of-service lights.
4. Remove *your* tags from switches. After all tags have been removed and all men accounted for, engage main line switch. Be sure cab switch is not engaged when leaving crane.
5. Personnel notified of job shall be advised that repairs have been completed.

RUNWAY REPAIRS

1. Before starting job, notify following giving details:
   A. Foreman of operations
   B. Crane foreman
   C. Crane foreman of adjacent operation, if runway is a joint runway.

   Note: Before starting work, check with crane operator to be sure that he has been informed.
2. Place warning signs on ground beneath repair operations.
3. If possible, rope off area beneath repair operations.
4. When men are working on runway:
   A. Whenever possible, cranes should be out of service and have switches tagged out.
   B. If crane cannot be taken out of service, the work area shall be isolated by means of emergency rail stops and streamers.
   C. If there is adequate runway clearance and cranes may be required to pass through work area, a safety observer shall be placed in the cab of the crane or cranes passing through area and one or more observers stationed on the runway with working personnel. Observers should preferably be selected from the repair crew performing the work.
5. Before passing through work area, cranes shall come to a full stop and cab observer shall get clearance to proceed from the runway observer.
6. When work is being performed on a joint runway, the preceding precaution and preparations shall be observed on the adjacent runway and in adjacent operations.

AT COMPLETION OF JOB

1. Remove all tools, material, equipment, and trash from runway and approaches. (Do not throw.)
2. Remove safety appliances such as rail stops, streamers, etc.
3. If any switches were disengaged, remove *your* tag and make sure that all men have removed their tags and are accounted for before engaging same.
4. Personnel notified of job shall then be advised that repairs have been completed.

GENERAL

1. Whenever conditions permit, board and leave cranes at established approaches.
2. Do not go on any runway while cranes are in operation, unless you are certain there is adequate clearance.
3. Do not throw tools, material, equipment or trash from cranes or runways. Use a handline or similar safe method.
4. Place all tools, material and equipment in such a manner that it will not contribute to tripping, or be knocked to the ground.
5. Do not pass or stand beneath loads that are suspended or being hoisted.
6. Use all prescribed personal safety appliances, such as hard hats, goggles, etc., where and when required.
7. Be sure to include safety in job planning and performance. Determine what hazards exist before starting job and be governed accordingly. Do not take unnecessary chances.

PROCEDURE TO BE FOLLOWED BY OUTSIDE PERSONNEL

All outside personnel, coming into a department for the purpose of working on or from cranes or runways, or whose work in any way exposes them to danger as the result of crane operation, shall observe the following procedure:

A. Clear in advance, as far as possible, through that particular department's repair personnel (electrical or mechanical general foreman) who will in turn make the necessary arrangements for their safety. This procedure must be followed, regardless of runway clearance or whether or not cranes are in operation.
B. The repair department will give the necessary clearance and acquaint outside personnel with the hazards that may be encountered on the job.
C. When required by job conditions, the repair department will supply a qualified man to safeguard outside personnel.
D. Immediately before boarding crane or going on runway, outside personnel shall be sure crane operator has received instructions in connection with work to be done.
E. All tools, material, equipment and trash shall be cleaned up immediately following completion of job.
F. Outside personnel shall observe all safety regulations of the department in which they are vorking.
G. Outside personnel shall advise repair department when their job has been completed.

RULES GOVERNING OILERS

1. Notify operator before boarding crane.
2. Whenever possible, board crane at an established approach.
3. Disengage and tag cab and main line switches before starting work.
4. Turn on out-of-service lights.
5. Do not lubricate cranes while in motion, except when job conditions require, i.e. applying gear coating, etc.
6. Remove all excessive and spilled grease and oil immediately after job is finished.
7. Report all broken lubrication lines to the repair department on each turn.
8. Do not go on crane runways while cranes are in operation unless absolutely necessary, and then *only* if there is adequate clearance.
9. When job is finished, turn off out-of-service lights, remove *your* tags, and if no other tags are on the main line switch, engage same. Never engage cab switch when leaving crane.
10. Notify operator that job has been completed.

By R. G. ORTHWEIN, Chief Electrical Engineer, A. J. Boynton & Co., Chicago, Ill.

Electrical Power Distribution and Utilization at Lone Star Steel Co.

. . . . with major electrical equipment for four mills confined to one motor room, economies were effected in electrical maintenance and operation . . . .

▲THE Lone Star Steel Co. is one of the newest members of steel producers in the United States. The processing facilities of the company which are located in the town of Lone Star in Morris County, Tex., and known as the E. B. Germany Works in honor of the president of the company, consist of the following major units:

Ore beneficiation plant.
By-product coke plant.
Blast furnace plant.
Open hearth plant.
Soaking pits.
Blooming and slabbing mill.
Skelp mill.
Two electric weld pipe mills and finishing facilities.
Ingot mold foundry.
Cast iron pipe foundry.

The original construction, comprising the ore beneficiation plant, by-product coke plant, and blast furnace plant was started in 1942 and completed in 1944, by the War Assets Administration, as part of the war-time iron and steel expansion program. In 1947 the properties were leased by the present owners and the blast furnace was blown in on October 25, 1947. In 1948 the entire plant was purchased outright from the War Assets Administration and has been in continuous operation since that time.

By 1949 the operation was so successful that negotiations were started which eventually led, first to the construction of a cast iron pipe foundry, and later to the addition of the present steelmaking, rolling, and finishing facilities. The production of cast iron pipe was started in 1950 and the remaining units started operations in 1953.

The principal merchantable products of the plant as it now exists are:

Coke.
Coke by-products.
Foundry and basic pig iron.
Prepared slag.
Ingots and slabs.
Coils.
Plate—up to 66 in. wide.
A.P.I. Casing—4.5 to 13.375 in. diam.
A.P.I. Line pipe—2 to 16 in. diam.
A.P.I. tubing—plain end and external upset end, 1.9 to 4.5 in. diam.
Centrifugal cast iron pipe—3 to 12 in. diam—12 and 18-ft lengths.

This paper is mainly concerned with the electrical power system of the plant.

POWER REQUIREMENTS AND SUPPLY

At the time the plant expansion program was contemplated, the existing demand load was 7700 kw. The installed generating capacity in the existing power house consisted of:

1—10,000 kw turbo-generator.
1— 7,500 kw turbo-generator.

The power station was built under war-time limitations and both machines were used machines at the time of their installation in 1943.

Preliminary power calculations for the plant expansion program predicted an ultimate 15-minute maximum demand load of 31,700 kw.

Short duration peak loads, caused by the slabbing mill and reversing strip mill, were calculated to superimpose an additional 7800 kw over and above the 15-minute maximum demand, or a total of 39,500 kw for short duration peaks.

A study of the steam and fuel balance revealed that it would be feasible and economical to replace the existing 7500-kw turbo-generator, which had seen its better days and had a high steam rate, with a modern 15,000-kw unit and install additional boiler capacity to supply this unit. This course was followed so that the present day installed generating capacity in the Lone Star Steel Co. power house is 25,000 kw.

Obviously this power supply had to be supplemented by purchased power. Previous to the steel plant expansion, Lone Star Steel Co. sold their excess power to the local utility company, the South Western Gas and Electric Co. Under pressure of ever-growing loads, the utility company had long felt the need of additional generating capacity in this territory and had a long-range program to fortify their system. With the advent of the additional steel plant load, agreements were made whereby the South Western Gas and Electric Co. would construct a steam generating plant adjacent to the steel plant which would supply Lone Star Steel Co. with the power needed above their own generating capacity.

This plant has been constructed, with an initial unit of 40,000 kw and a planned future addition of a second 40,000 kw unit. Thus, sufficient power has been made available for Lone Star Steel Co.'s present operations and any foreseeable future expansion.

Automatic load regulators have been provided on Lone Star Steel Co.'s new turbine, as well as on the South West Gas and Electric Co.'s turbine, to divide the short duration peak loads of the steel plant in proportion to the rated capacity of the two units.

Actual load readings taken during the month of January, 1954, show the following values of 15-minute maximum demand:

Lone Star Steel Co.—Generator No. 1. . 15,264 kw
Lone Star Steel Co.—Generator No. 2. . 9,360 kw
From South Western Gas & Electric Co. 3,072 kw
Total 15-minute maximum demand. . 27,696 kw

These values are approaching the preliminary calculated values, bearing in mind that full scale production on all facilities had not been attained at the time of these readings.

SELECTION OF SYSTEM VOLTAGES

The distribution voltage of the blast furnace plant is 7200 volts. This voltage is normally considered a good voltage for direct application to large a-c motors, if the transmission distances are not too long.

The total connected horsepower of the steel plant addition is 95,702 hp. This load can be segregated into the classifications shown in Table I.

TABLE I

Steel Plant Load Tabulation

Item	Description	Connected horsepower
1	Large rotating a-c machines — 1750 to 8500 hp	27,250
2	Medium size rotating a-c machines — 125 to 1500 hp	11,075
3	A-c motors — 1 hp to 100 hp — including lighting load	12,188
4	230 v d-c constant potential drives — from rectifiers	13,063
5	Large d-c variable voltage mill drives	16,500
6	Variable voltage d-c auxiliary drives	10,126
7	Large pipe welding machines	5,500
	Total connected horsepower	95,702

For the purpose of voltage selection and plant load for that matter, items Nos. 5, 6 and 7 of Table I need not be considered, since they receive their power supply from the motor-generator sets, whose drive motors have been included under large and medium size a-c rotating machinery. As a matter of interest, the total installed generator capacity for this group of drives is 30,120 kw, ranging from small exciters to a 4000-kva generator for the large pipe mill welder.

With this tabulation, it could readily be seen that all the large a-c rotating machines listed under item No. 1 could be well adapted for a voltage of 13,200 volts, and all conversion equipment for machinery under items Nos. 2, 3, and 4 could have primary voltages of 7200 volts or any other higher voltage.

The modern trend is toward higher distribution voltages with the inherent advantage of smaller conductors, lower fault currents, and capacity for future expansions.

With this view in mind, a careful study and comparison of costs was made, which revealed that a considerable economy could be effected by selecting a primary distribution voltage of 13.8 kv, and eliminating entirely the commonly used intermediate voltage of 6900 volts. It was decided to select a generating voltage of 13.8 kv for the new 15,000-kw turbo-generator and the following voltage classifications were established for the steel plant:

1. 13.8 kv for all a-c rotating machines 1750 hp and larger.
2. 2400 volts for all a-c rotating machines 125 hp to 1500 hp.
3. 480 volts for all a-c rotating machines up to 100 hp.
4. 250 volts d-c for all d-c constant potential drives.

The primary voltage for conversion to 2400 volt a-c, 480 volt a-c, and 250 volt d-c was selected to be 13.8 kv. All a-c distribution circuits were designed for grounded neutral service. All transformers are "wye" connected on the secondary side, with neutrals solidly grounded on the 480-volt system and through grounding resistors on the 2.4 and 13.8-kv systems.

13.8 KV DISTRIBUTION SYSTEM

The total connected load of the steel plant, connected to the 13.8-kv system, is 63,576 hp. Latest load readings indicate an overall demand factor of 0.372 and a power factor of 0.965 leading.

The main primary distribution system of the plant is shown in Figure 1. In the upper left hand corner is shown the Ellison Power Station of South Western Gas and Electric Co. The 40,000-kw turbo-generator generates at 13.8 kv, which is stepped up to 69 kv and connected through a ring bus to two transmission lines, one leading to the Hughes Spring substation and one to the Longview substation. The 69-kv system is also interconnected with other utilities in the Southwest. Two overhead transmission lines connect the 69-kv system of the utility company with the 69-kv bus of Lone Star Steel Co.'s outdoor substation, adjacent to the power house.

The station contains one 69/7.2-kv, 3-phase trans-

former, rated 8000 kva, and two 69/13.8-kv, 3-phase transformers rated 10,000/12,500/16,700 kva each. The 8000-kva transformer connects to the original 7.2-kv bus, while the other two transformers are connected to the new 13.8-kv bus.

The diagram also shows the original 10,000-kw turbo-generator connected to the 7.2-kv bus, and the new 15,000-kw turbo-generator connected to the 13.8-kv bus.

The primary circuit breakers on the 69-kv side of the transformers have an interrupting rating of 1,500,000 kva.

The new 13.8-kv switchgear equipment in the power house, mill motor room and open hearth substation are of heavy duty, indoor, metal clad construction. All circuit breakers are removable air-circuit breakers with a continuous rating of 1200 amperes and a 3-phase interrupting rating of 500,000 kva.

The power house switchgear controls the following apparatus or circuits:

2—incoming lines from 69/13.8-kv transformer.
1—15,000-kw turbo-generator.
1—2000-kva, 13.8-kv/480-volt auxiliary transformer.
4—steel plant feeders.

The bus is sectionalized by a tie circuit breaker.

The motor room switchgear controls all the steel plant load. The gear is centrally located in the main mill motor room and is 90 ft long. The switchgear controls the following apparatus or circuits:

4—incoming lines from power house.
2—2400-volt load center feeders, 6000 kva each.
2—480-volt load center feeders, 4—1000 kva each.
2—250-volt rectifier feeders, 1500-kw each.
2—open hearth substation feeders.
1—7000-hp induction motor full voltage starting.
1—8500-hp synchronous motor neutral reactor starting.
1—4500-hp synchronous motor neutral reactor starting.
1—2000-hp synchronous motor neutral reactor starting.
3—1750-hp synchronous motor neutral reactor starting.
1—bus sectionalizing unit.
2—spare feeder units.

A duplex control board has been provided with this switchgear, which contains all necessary meters, switches, indicating lights, together with mimic bus and devices for complete system set-up and control of the entire steel plant load from this location.

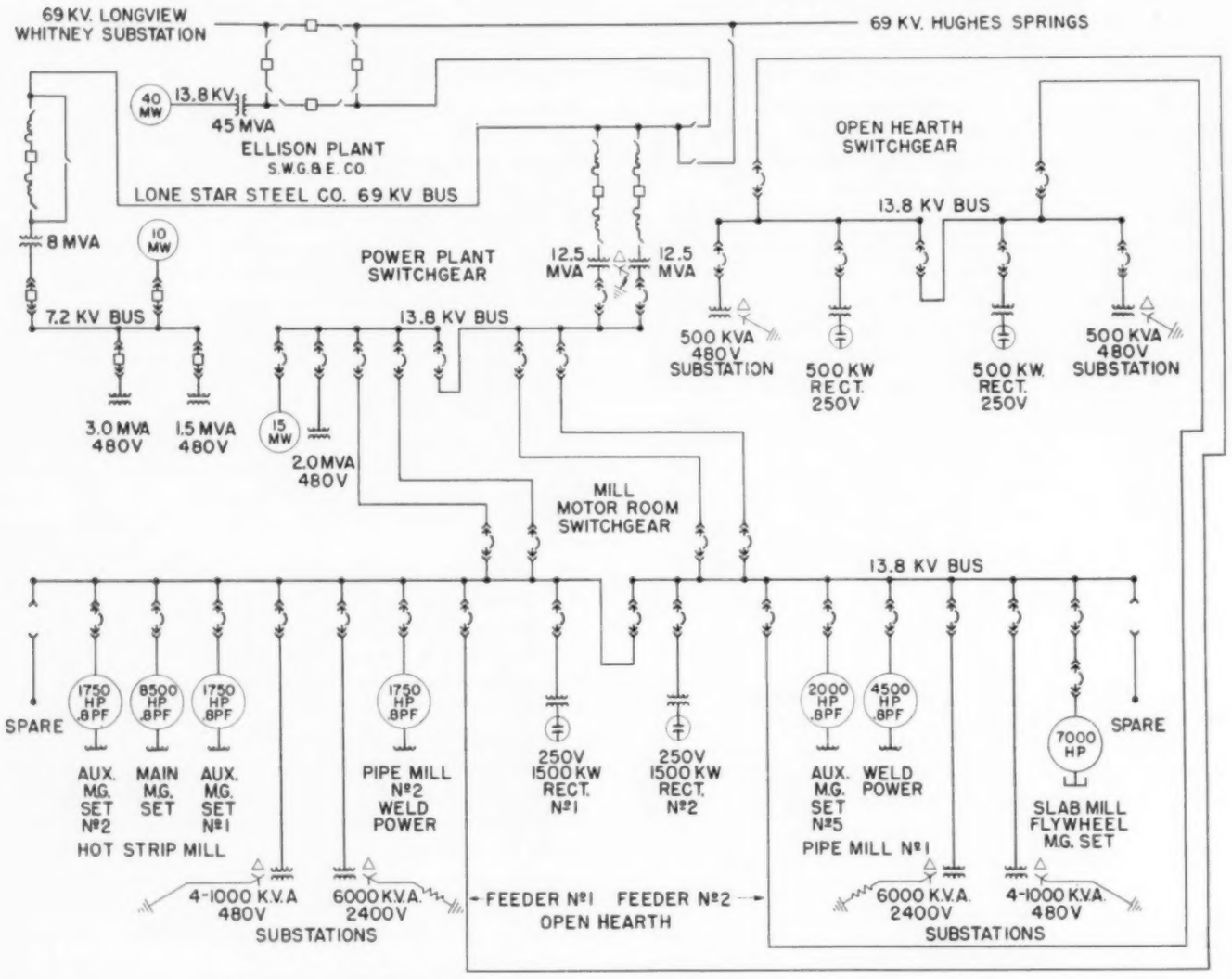


Figure 1 — One line diagram shows 13.8-kv main primary distribution system.

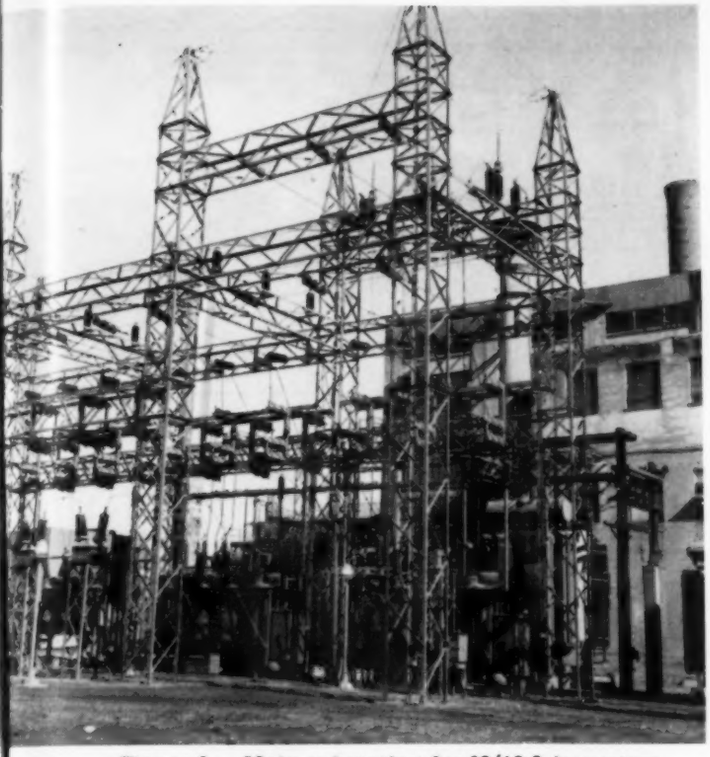


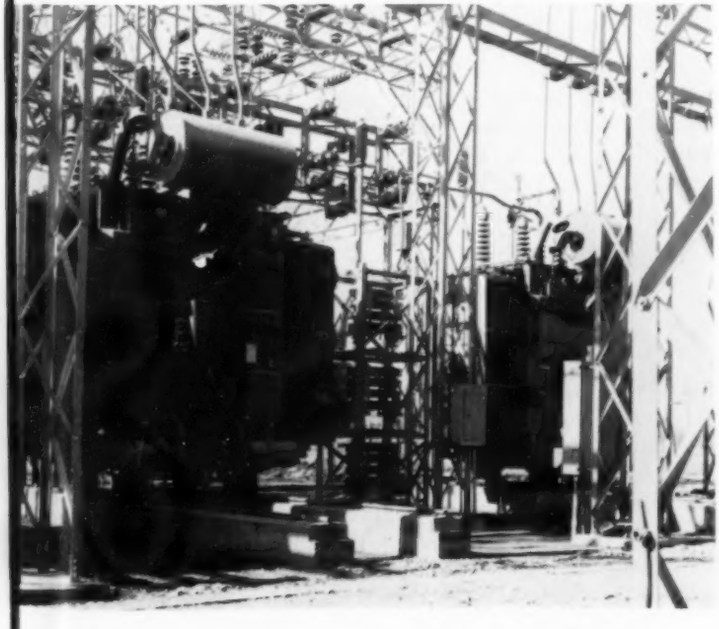
Figure 2 — Main substation for 69/13.8-kv system.

The open hearth switchgear controls the following apparatus or circuits:

2—incoming lines from motor room switchgear.
2—480-volt unit substation feeders, 500 kva each.
2—250-volt rectifier feeders, 500 kw each.
1—bus sectionalizing unit.

The 13.8-kv feeders from the power house switchgear to the motor room switchgear and from there to the open hearth switchgear are installed in underground duct lines encased in concrete. All cables are single conductor, shielded, neoprene jacketed cables, cabled together in manholes and fireproofed with asbestos tape and asbestos cement. Figure 2 shows the 69/13.8 kv main substation with the power house in the background. Figure 3 shows the 12,500-kva, 69/13.8-kv, 3-phase transformers in the main substation. Figure 4 shows the new 15,000-kw, 13.8-kv turbo-generator in the power house.

Figure 3 — These 12,500-kva, 69/13.8-kv, 3-phase transformers are located in the main substation.



2400-VOLT DISTRIBUTION SYSTEM

The total connected load of the 2400-volt system is 11,950 hp. Latest load readings indicate an overall demand factor of 0.404. The general arrangement of the system is shown in Figure 5. The load has been divided into two unit substations, located at either end of the motor room, in close proximity to the major units, which resulted in minimum lengths of feeder cables.

Each station is provided with two 3000-kva transformers, which are located in the basement and are connected by short bus duct feeders to the switchgear equipment, directly above, on the main floor. This arrangement permits expansion at either end of the stations. The primary feeder arrangement is such that either primary feeder or any one of the four transformers can be taken out of service without interruption of power. A view of the 2400-volt switchgear is shown in Figure 6.

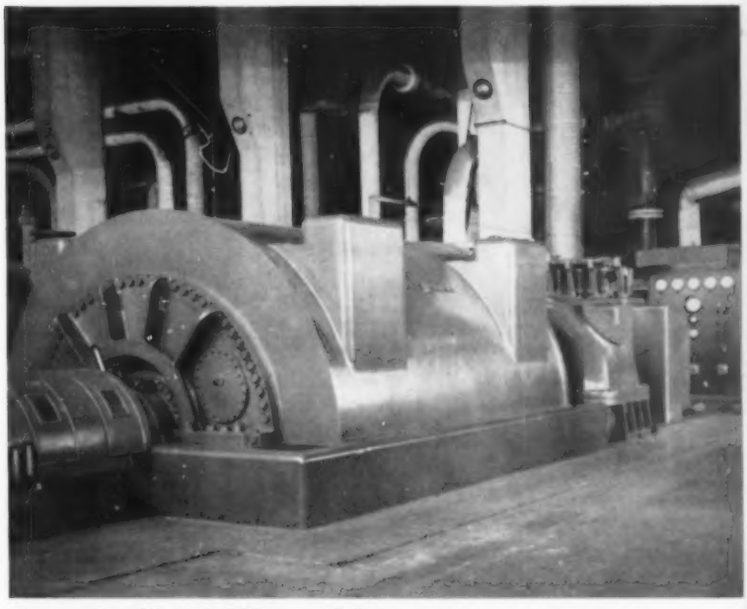


Figure 4 — New 15,000-kw, 13.8-kv turbo-generator was installed in power house.

480-VOLT DISTRIBUTION SYSTEM

The total connected load of the 480-volt system in the mill area is 10,380 hp. Latest load readings indicate an overall demand factor of 0.45. The general arrangement of this system is shown in Figure 7. The load has been divided into eight 1000-kva unit substation load centers, conveniently located throughout the plant in close proximity of the load, resulting in minimum cable length requirements for the secondary feeders. The primary feeder and secondary bus tie arrangements are such that, by manipulation of the primary selector switches and bus tie circuit breakers, any one of the eight transformers and either one of the primary feed-

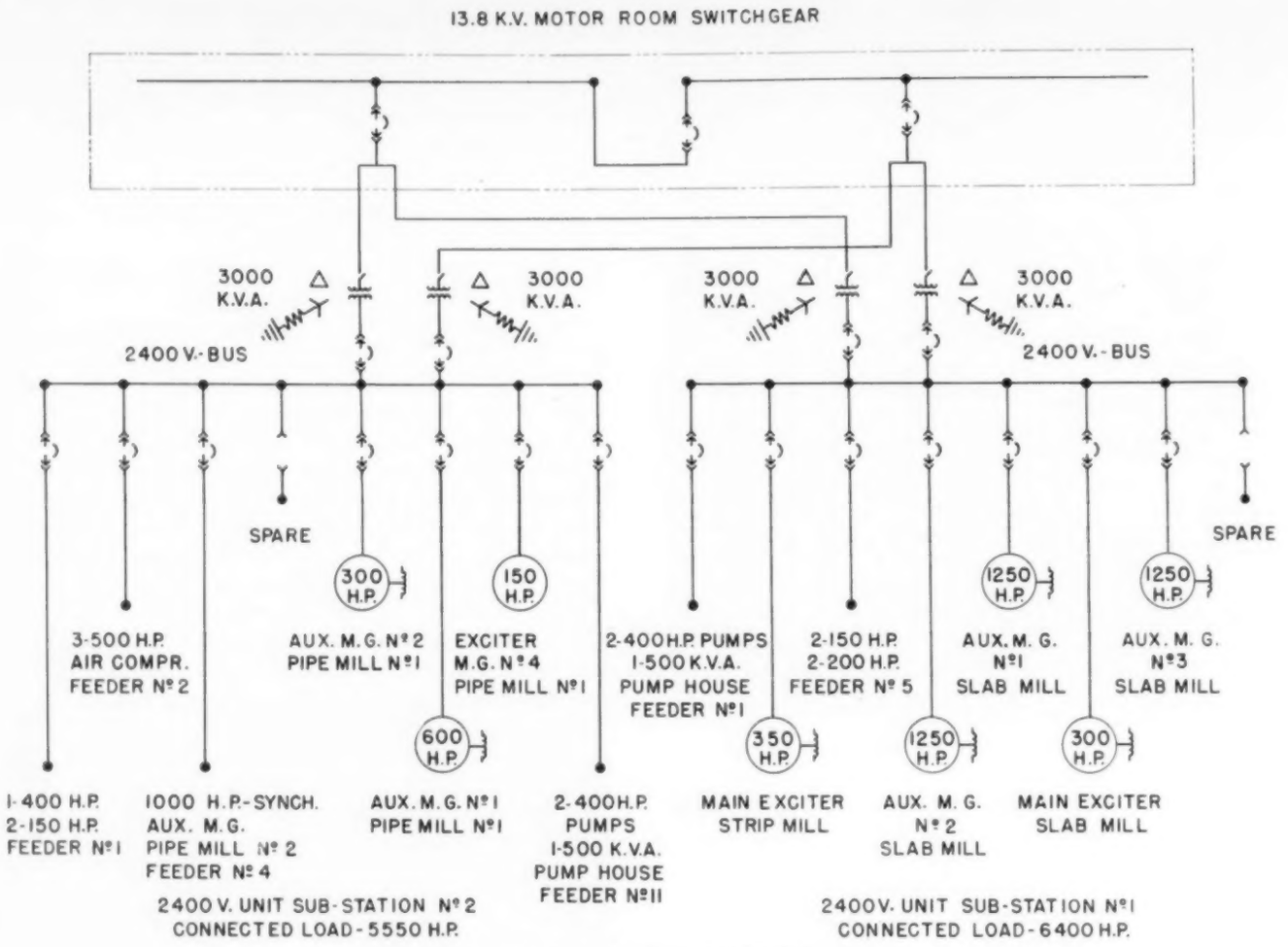

13.8 K.V. MOTOR ROOM SWITCHGEAR
3000 K.V.A.
3000 K.V.A.
3000 K.V.A.
3000 K.V.A.
2400 V.-BUS
2400 V.-BUS
SPARE
SPARE
300 H.P.
150 H.P.
1250 H.P.
1250 H.P.
600 H.P.
350 H.P.
1250 H.P.
300 H.P.
3-500 H.P. AIR COMPR. FEEDER Nº 2
AUX. M. G. Nº 2 PIPE MILL Nº 1
EXCITER M.G. Nº 4 PIPE MILL Nº 1
2-400 H.P. PUMPS 1-500 K.V.A. PUMP HOUSE FEEDER Nº 1
2-150 H.P. 2-200 H.P. FEEDER Nº 5
AUX. M. G. Nº 1 SLAB MILL
AUX. M. G. Nº 3 SLAB MILL
1-400 H.P. 2-150 H.P. FEEDER Nº 1
1000 H.P.-SYNCH. AUX. M.G. PIPE MILL Nº 2 FEEDER Nº 4
AUX. M.G. Nº 1 PIPE MILL Nº 1
2-400 H.P. PUMPS 1-500 K.V.A. PUMP HOUSE FEEDER Nº 11
MAIN EXCITER STRIP MILL
AUX. M. G. Nº 2 SLAB MILL
MAIN EXCITER SLAB MILL
2400 V. UNIT SUB-STATION Nº 2 CONNECTED LOAD - 5550 H.P.
2400 V. UNIT SUB-STATION Nº 1 CONNECTED LOAD - 6400 H.P.

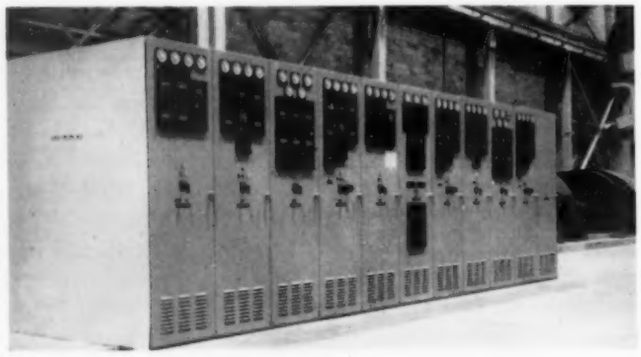
Figure 5 — One line diagram of 2400-volt system.

ers can be taken out of service without interruption of power.

Figure 8 shows a typical 1000 kva substation. Each substation contains a primary disconnect switch, 1000-kva pyranol filled transformer, main secondary circuit breaker, bus-tie circuit breaker and a group of feeder circuit breakers with ammeters, voltmeters and watt hour meters.

The switchgears are of the draw-out air circuit breaker type with cascaded interrupting ratings of 25,000 amperes on the feeder breakers and 50,000 amperes on the main and tie circuit breakers. The branch feeders are connected to various groups of control centers. A total of 27 control centers, averaging 20 feet in length, were installed in the mill area. Each control center contains a main circuit breaker, circuit breaker combination starters, and all other control equipment for the machinery in the respective area. The centers were completely factory wired with all interlocking and all wiring connected to terminal boards. This feature saved a tremendous amount of wiring and field labor and was largely responsible for completion of the installation in record time. A view of a typical control center is shown in Figure 9.

Figure 6 — Shown here is 2400-volt switchgear in motor room.



The lighting system is supplied from separate 480-volt feeders through 100 distribution units. Each lighting distribution unit consists of a 480-volt circuit breaker, a 25-kva 480/120/208-volt dry type transformer and 24-circuit lighting panel. These units were shop assembled and wired with the equipment mounted on channel iron frames, which resulted in considerable saving of field labor and a minimum of temporary wiring for construction purposes. All exterior flood lighting and yard lighting is supplied from the nearest lighting distribution units through magnetic contactors, which are remote controlled from the motor room.

250-VOLT D-C SYSTEM

The total connected load of the constant potential d-c system in the mill area is 8770 hp. This load is supplied through two 1500-kw rectifiers. Latest load read-

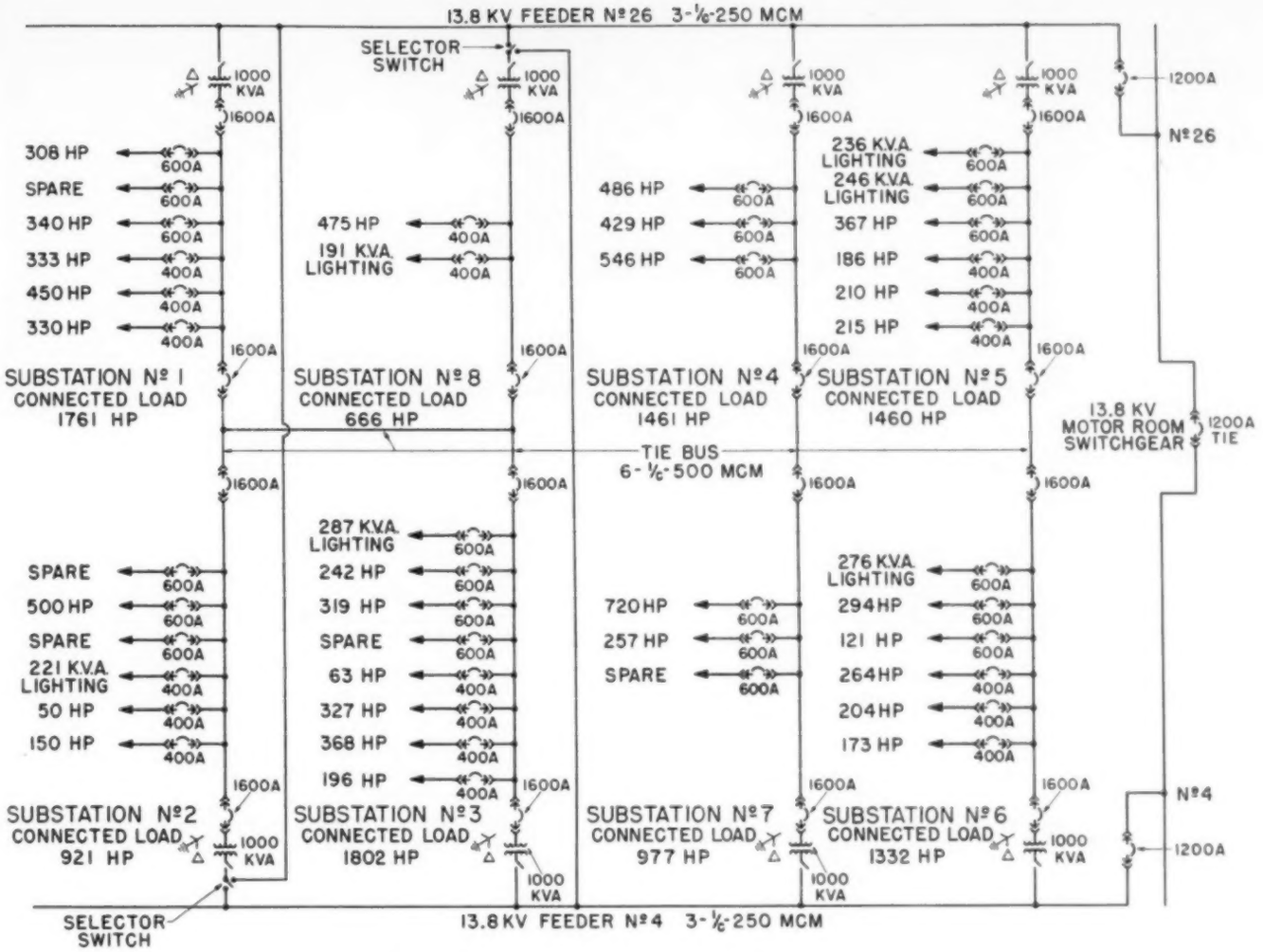
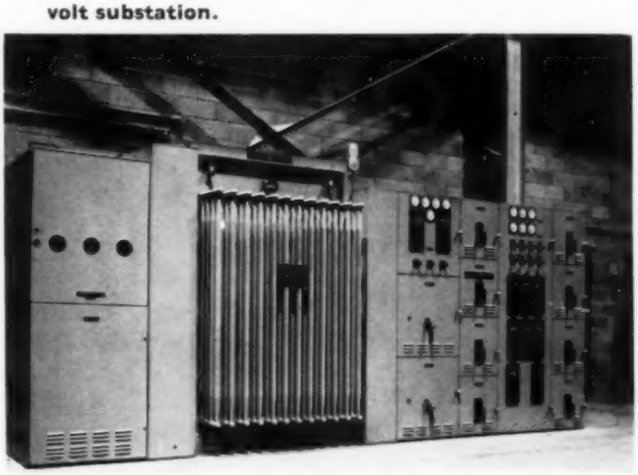


Figure 7 — One line diagram of 480-volt system.

ings indicate a demand factor of 0.214. The load consists mainly of cranes and mill auxiliary drives. The general arrangement and load distribution are shown in Figure 10. The rectifiers are pumpless mercury arc rectifiers. The d-c switchgears are metal clad with draw-out air circuit breakers and are connected with a tie bus, which permits taking one of the rectifiers out of service for maintenance without interruption of power.

Figure 8 — Shown here is a typical 1000-kva, 13.8 kv, 480-volt substation.

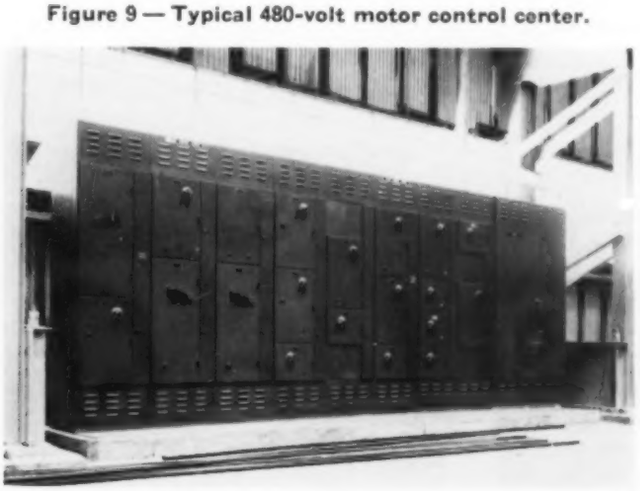


OPEN HEARTH SHOP

The total connected load of the open hearth shop is 6125 hp. This consists of 1220-hp, 480-volt, a-c load and 4905 hp of 250-volt d-c load for cranes.

Latest load readings indicate an overall demand factor of 0.254. The low demand factor is due to the diversity between crane loads. The general arrangement and load distribution are shown in Figure 11.

Figure 9 — Typical 480-volt motor control center.



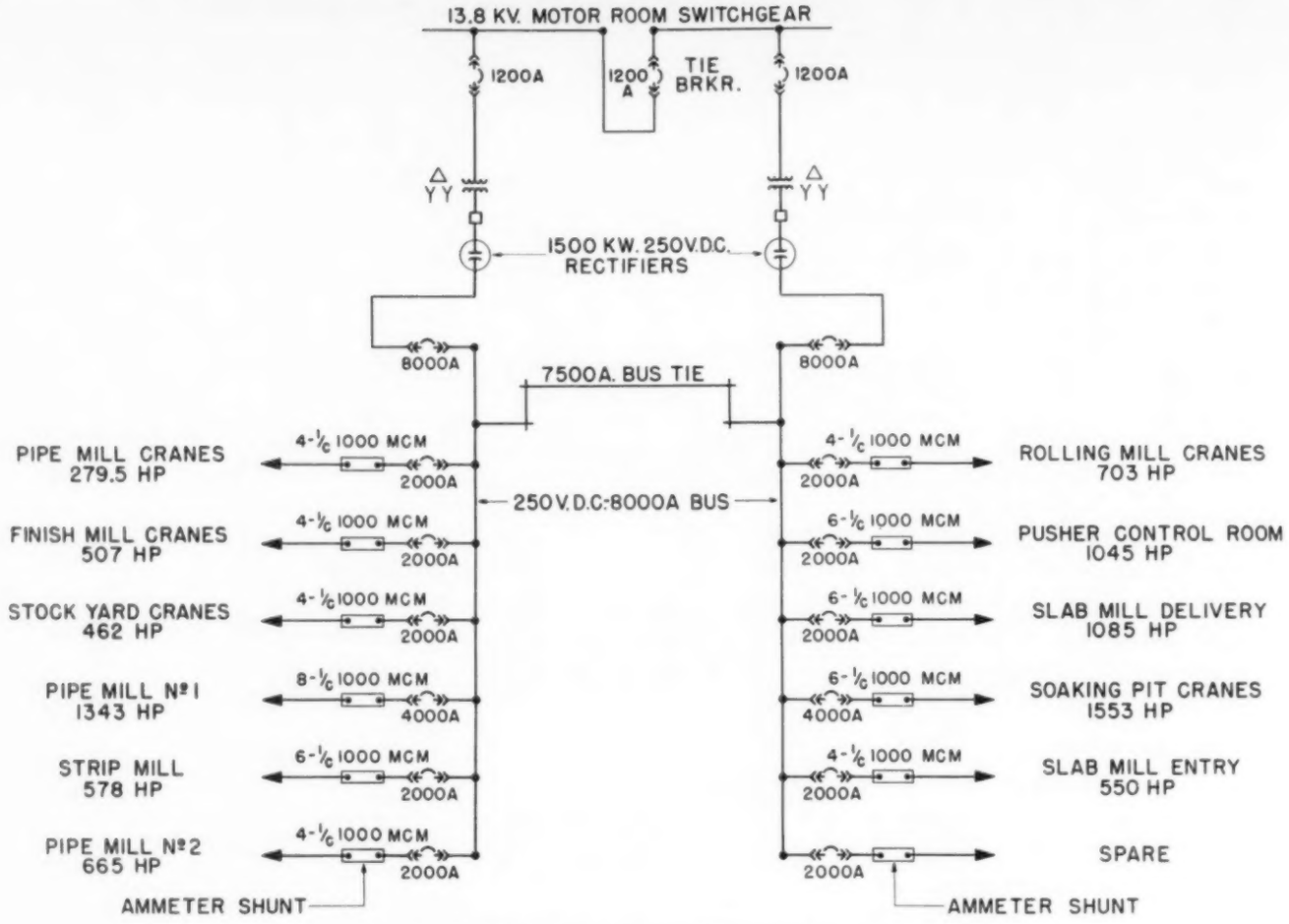


Figure 10 — One line diagram of 250-volt, d-c system.

The dual supply system has been carried out on the primary feeders as well as the a-c and d-c conversion units, which permits maintenance operations without power interruptions. It is to be noted that the 250-volt, d-c system has been provided with a tie-circuit to the d-c system of the blast furnace plant, which has an installed rectifier capacity of 1300 kw.

THE MOTOR ROOM

The most outstanding feature of the plant is the arrangement of the main mill motor room. A general view of the building and equipment is shown in Figure 12. An equal amount of equipment is located in the basement.

The motor room is 650 ft long by 50 ft wide. It houses all the power distribution and conversion equipment previously described in this paper, as well as the main drive equipment, generators and controls of the slabbing mill, hot strip mill, and No. 1 pipe mill. It also houses the main weld power motor-generator set and controls for No. 2 pipe mill. The flow of production in the mills follows along one side of the motor room, through the slabbing mill and hot strip mill, then crosses over and returns along the other side of the motor room through the pipe mills. This layout made it feasible to locate all control panels for main drives and auxiliaries along these walls as close as possible to the drive motors, and the variable voltage motor-generator sets supplying the various drives were located in similarly advantageous locations.

The following figures show the major pieces of equipment in more detail. Figure 13 shows the slabbing mill main drive equipment with its two 3500-hp main roll drives and 2500-hp edger drive. Figure 14 shows the opposite side of the slab mill main drive, the main motor-generator set for this drive consisting of a 7000-hp, wound-rotor motor, a 195,000-hp/sec steel plate flywheel and four 2000-kw generators. Also shown here are complement of control motor-generator sets and a 480-volt control center.

There are three slab mill auxiliary motor-generator sets. Figure 15 shows the other of these auxiliary motor-generator sets and associated control panels. In the background are two 1500-kw rectifiers and d-c switchgear.

The No. 1 pipe mill weld power motor-generator set consists of a 4500-hp synchronous motor and 4000-kva generator. Pipe mill No. 1 also has auxiliary motor-generator sets with a 2000-hp synchronous motor, one 800-kw and one 575-kw generator.

Figure 16 shows the general area of the reversing hot strip mill equipment. The picture shows the 7000-hp, double-armature main drive, the main drive motor-generator set, consisting of an 8500-hp synchronous motor and two 3000-kw generators, two auxiliary motor-generator sets, each driven by a 1750-hp synchron-

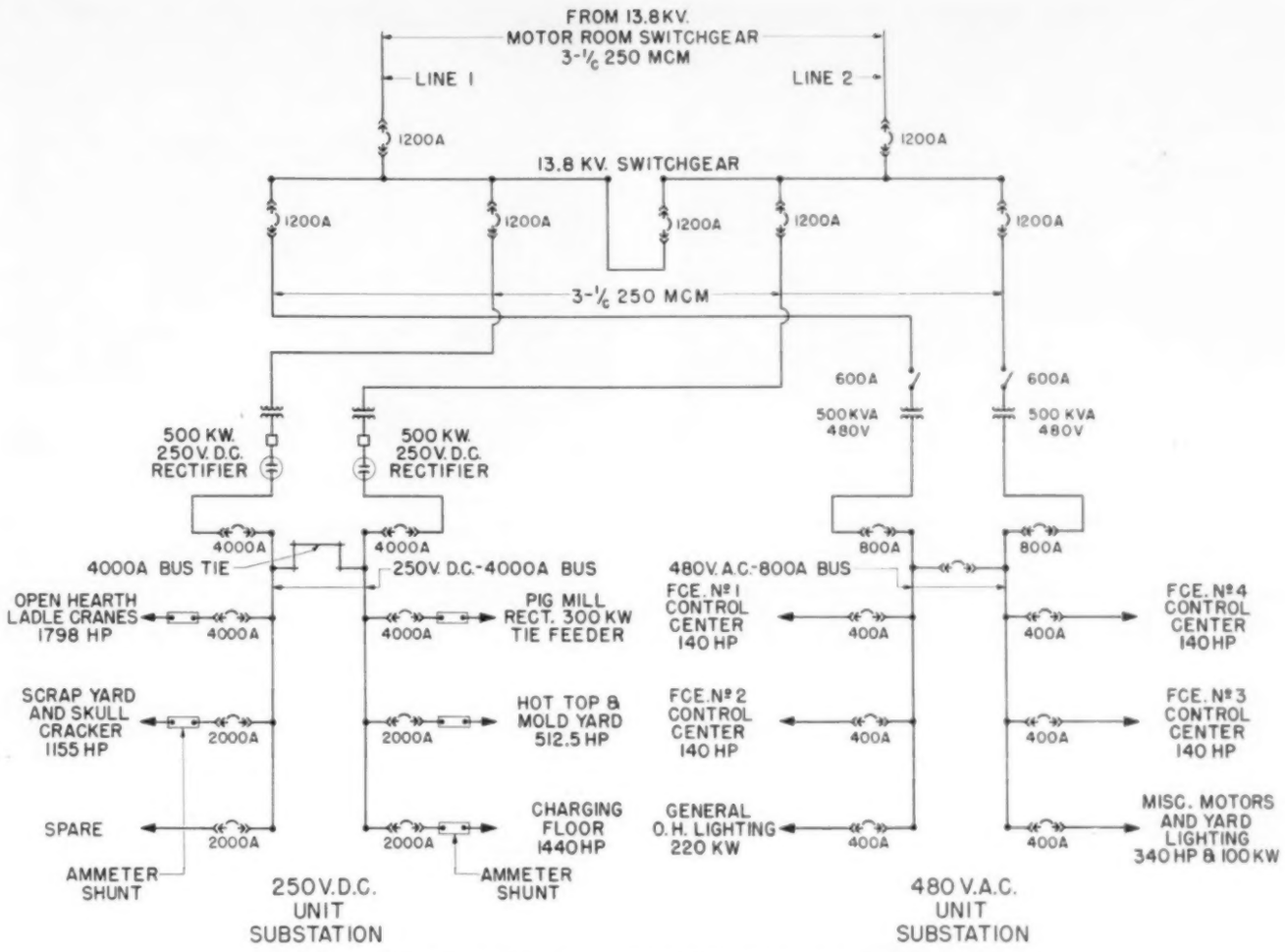


Figure 11 — One line diagram of power system for open hearth department.

ous motor and a complement of exciters and rotating regulator motor-generator sets and auxiliary variable voltage control panels. In the background at the left is shown the weld power motor-generator set for No. 2 pipe mill consisting of a 1750-hp synchronous motor and a 1500-kva generator and associated control equipment.

From the compactness of the arrangement it can be seen that the layout has resulted in the ultimate economy in building requirements, as well as minimum lengths of connecting buses and cables.

The motor room is supplied with clean air by means of two electro-static air cleaners, one on each end of the building. All large machines are force ventilated by a down-draft recirculating and cooling system.

The fact that most of the major electrical equipment for the four mills is confined to one motor room has resulted in a minimum of supervisory and operating personnel, which fact also contributes greatly to the ease of maintenance operations.

Figure 12 — Rolling mill motor room houses power distribution and conversion equipment, main drive equipment, generators and controls and main weld power motor-generator sets.

Figure 13 — Slabbing mill is driven by two 3500-hp main roll drives, and 2500-hp edger drive.

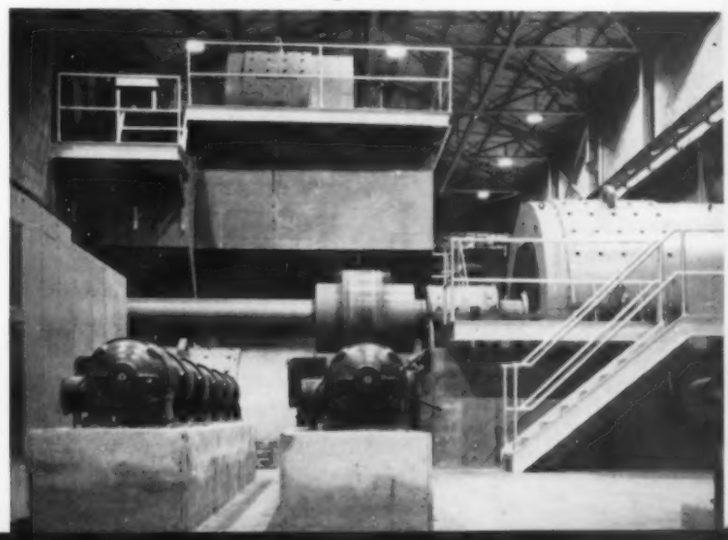


Figure 14 — The main motor-generator set for the slabbing mill consists of a 7000-hp wound-rotor motor, with a 195,000-hp/sec steel plate flywheel and four 2000-kw generators.

DISCUSSION

PRESENTED BY

HARRY H. ANGEL, Electrical Engineer, Bethlehem Steel Co., Bethlehem, Pa.

R. G. ORTHWEIN, Chief Electrical Engineer, A. J. Boynton & Co., Chicago, Ill.

JOHN F. HEADLEE, General Supervisor, Electrical Engineering Dept., United States Steel Corp., Fairless Hills, Pa.

A. D. HOWRY, Electrical Engineer, Alan Wood Steel Co., Conshohocken, Pa.

L. G. LEVOY, Industrial Power Engineer, Industrial Engineering Section, General Electric Co., Schenectady, N. Y.

R. W. SHEFFLER, Design Engineer, Engineering Bureau. United States Steel Corp., Fairless Works, Fairless Hills, Pa.

H. H. Angel: There is always a difference of opinion relative to the upper limits of horsepower on 440-volt motors. In this case, the selection of 100-horsepower appears to me to be a bit low. A good many people select 200 and 250-horsepower as the upper limit. I would like to obtain Mr. Orthwein's comments on this item.

Two incoming lines feed each of the two sectional buses in the motor room. The one-line diagram shows two feeders in one end. Is this the actual way or does a feeder enter each end? It appears that each sectionalized bus has about 27,000 kva load at about 1100 amperes and a 2000-ampere bus could easily handle the load if the feeder was at one end only.

I notice that each lighting system unit consists of a 480-volt circuit breaker, a 25-kva 480/120/208-volt dry type transformer and a 25-circuit lighting panel. I would like to know how the economics of this system compares with the 115/230-volt three-wire single phase systems, which a good many people still use. I would also like to know if any thought had been given to a system of 480/277 volts for the application of a very limited amount of fluorescent lighting.

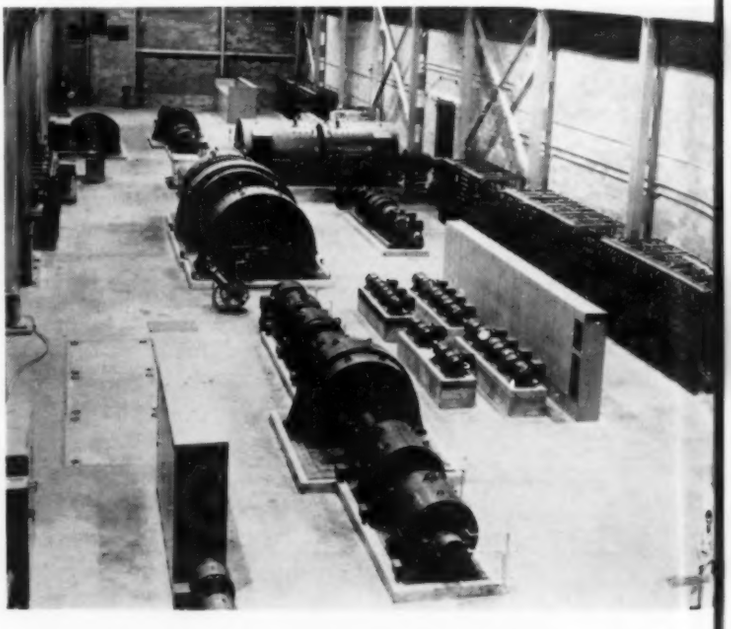
Figure 15 — Auxiliary motor-generator sets and control for slabbing mill.

R. G. Orthwein: The first question deals with the limitation or upper horsepower limits of 440-volt motors. There is quite a difference of opinion about this limitation. One main reason for our selection of 100-hp maximum was the cost involved and the additional transformer requirements which would have been necessary on the 480-volt system for larger ratings. Particularly since we had standardized on unit substations of 1000-kva rating, it is quite evident that not many 200-hp or 250-hp motors could be connected to such a station. The economics of it worked out in favor of the lower grouping.

The two incoming lines feed each of the two sectionalized buses of the 13,000-volt switch gear. Actually, the feeders connect on each side of the sectionalized bus. It may appear that there is a little too much feeder capacity provided, however, the possibility of a feeder outage, and future expansion has been a major consideration of that.

The 3-phase, 4-wire lighting system has a definite advantage from a cost standpoint. It is cheaper than

Figure 16 — Main drive and auxiliaries for reversing hot strip mill.



the three-wire system which is more commonly used in older steel plants. It requires less wire and less conduit in the arrangement, and the way these 25 kva units were installed saved a considerable amount of field labor.

Some thought was given to 480/277 volts fluorescent application, but the time element and delivery problems involved in getting this mill in operation were important; therefore we standardized on incandescent high bay lighting. This resulted in identical lighting equipment throughout the plant with installations typical for all bays.

J. F. Headlee: I always try to look at the economics in design and operation. You stated that you used single conductor cables and I was wondering about the justification of that rather than a three-conductor cable.

The author has a synchronous motor with reactor starting and I note that the total capacity that is generated by the plant self-generator and his purchased power is only slightly over his maximum demand, so that when you start to load your motors on a system and supply from both sources—purchased and self-generated—undoubtedly there is a dip in voltage there. Do you or do you not get this?

The author made a statement of having a power factor in the overall power system of 0.965 leading and I was wondering whether or not that was an error and perhaps should have been lagging.

I ask that question on the basis that usually you find with an overall leading factor you get into the problem of instability and your swing curve usually shows that up.

On the 440-volt system grounding and the 2400-volt system which are grounded through a resistor, what values of resistors do you use?

When you are tied in with a public utility; where you are purchasing power, what rates are used and how do you control your maximum demand and probable penalties on so small a self-generating plant.

I noted on the chart you indicated full loading on one generator and pretty good loading on the other generator. Then again, from purchased power you only had a little "drop in the bucket." Undoubtedly you do have quite a bit of drag at different times and your load dispatcher, in his efforts to keep those peaks down, must have quite a problem, and I believe you must have peaks far more sizeable than indicated on the maximum demand.

R. G. Orthwein: On the question of single-conductor cables versus three-conductor cables, we found that it was more economical to do it that way in an underground duct system where you keep the three single conductors in one duct run and have the same effect as a three-conductor cable. However, in the manholes it is much easier to make splices on a single-conductor cable than on a three-conductor cable, and by cabling them together in the manholes and fireproofing the cables, you still have the same effect as a three-conductor cable. Furthermore, single-conductor cable is much easier to handle during construction. Three-conductor cables of the larger circular mill sizes with high voltage insulation get quite bulky and cumbersome to handle in manholes. The greatest advantage, of course, was having such a great amount of cable of the same size which was used for the feeders all over the plant site, sticking to one particular conductor size and type for all 13,000-volt feeders and grouping them in parallel circuits when necessary. This resulted in obtaining the very lowest price for these cables and obtaining a suitable delivery date and priorities.

Regarding voltage dips when starting the large synchronous motors, there are naturally some dips, but we have not experienced any significant difficulties. These machines, of course, are started when the mill load is down, since the mills cannot be operated before these machines are in operation.

The figures of generator loads and purchased power may have been somewhat misleading, as these readings were taken before the 40,000-kw generator of South Western Gas and Electric Co. went on the line.

With regard to the 0.965 leading over all power factor of the plant, I agree with Mr. Headlee that this is not a perfect condition and it will be remedied in the future. We calculated a system to get as even a balance of leading and lagging reactive kva as possible, to bring the power factor as close to unity as possible.

All synchronous motors have been with tapped field resistors, which will permit correction of the power factor pattern as the mills get into full production.

Regarding system grounding, the 480-volt system neutrals are solidly grounded. The neutrals of the 3000-kva, 2400-volt transformers are grounded through resistors having a 10-second rating of 1200 amperes, 1.16 ohms.

The question of power rates I would rather by-pass, since I am not at liberty to discuss them.

Regarding the peak loads, the figures I stated were 15-minute maximum demand loads, and peak loads probably at the worst conditions would vary about 8000-kw above those. However, automatic load regulators have been provided on the turbines of both the Lone Star Steel Co. and the Power Co., which are set for a base load and to take a certain amount of percentage of the short duration peaks. The ratio agreed upon is in direct proportion to the rated capacity of the two machines.

A. D. Howry: As the paper developed I mentally compared this system with that at Alan Wood Steel. The conception of Lone Star Steel in 1944 coincided with the initiation of our power system modernization and expansion.

Lone Star Steel's problem was one of power capacity, both internal, and the interconnection with the utility company, the engineering problems involved in the solution of internal capacity, the development of utilities capacity, and the interchange of power, all add up to a very interesting and instructive discussion.

Our initial problem was one of frequency, decision was made to convert the steel works division to 60-cycle on purchased power, a 7500-kva turbine being added later and operating in parallel with the local utility company. The power contract being for incoming power only, with a 95 per cent power factor clause.

As the Lone Star Steel contract allows interchange of power, I would like to ask Mr. Orthwein what kind of power agreement is involved?

The installation of transformer stations for 440-volt supply is very interesting, I note, that in line with modern practice, all secondaries are wye connected and grounded, I would like to ask Mr. Orthwein if these various load centers operate independent with individual grounds, or in case of paralleling do you have any problems of circulating current?

R. G. Orthwein: On the question of interchange of power between Lone Star generating plant and the utility company, they have such an agreement. However, the load of the steel plant is now above the generating capacity of the Lone Star station, so additional power will have to be purchased under any circumstances. However, they have an agreement that in case of emergency they interchange power.

As far as the grounding system of the transformers are concerned, each transformer is individually grounded, of course, and a complete grounding grid system has been installed throughout the plant.

With regard to transformer operation in parallel, the transformers are not intended to be operated in parallel, although in emergency they could be operated that way. In the case of transformer failure or maintenance operation, the transformer is taken out of the circuit and the tie circuit breaker is closed in to supply loads to the particular switchgear which has lost its transformer.

All transformer secondary main breakers and tie-circuit breakers are under supervisory control by the motor room attendant, and are electrically operated from the duplex control board.

L. G. Levoy: It always takes a certain amount of courage and foresight when you step into a steel plant that is operating at 7200-volts and tell them they should have 13,800. In this case 13.8-kv is certainly the right choice. Smaller steel plants can use 6900-volts successfully and even larger plants use the voltage, and we have a great many examples of this; but the plant engineers who use 13,800 are always glad they did.

In connection with the load regulating end of this system, I would like to ask several questions. A load regulator can be put on for the purpose of lowering the 15-minute demand and a good many load regulators are in use for that purpose. A second purpose might be to decrease the magnitude of the short transient power swings on the system, which may come on and go off within a few seconds, and do not appreciably affect the 15-minute demand.

Some utility companies are sensitive to these short spikes of power, and in order to take them off of the system requires a really high-speed regulating system. As a matter of fact, if the loading is instantaneous (a unit function type of load) , it is impossible to take that first peak off even with a fast regulator. But if the load comes on gradually, as it does in many cases, in five or ten seconds, then a high-speed regulator can take it off successfully, or at least take a part of it off.

I would like to ask Mr. Orthwein if he has any records of the performance on shock loading of this system as to how successful the load regulators are in taking off the transient part of the shock load? We have some expected performance data for the load regulator, but no actual test data showing their performance on this system. Probably the best way to get that information is with an oscillograph, although high-speed recording instruments can do a pretty fair job. It would also be interesting if Mr. Orthwein would give us a little more of the background of why they put these load regulators on.

I think that from what he said, they started out with a weak power system and that was probably necessary. I gather now the power system is built up so perhaps they are not so sensitive to these load spikes. However, I would appreciate a little more discussion on that point.

R. G. Orthwein: The load regulators at Lone Star are provided for the purpose of obtaining quick response of the turbine governors to absorb peak loads caused by the swinging loads of the reversing hot strip mill. The power company was rather concerned about this condition.

No complete performance records are available at this time since the 40,000-kw unit of South Western Gas & Electric Co. has not been put on the line as yet. However, the regulator on the 15,000-kw Lone Star turbine has done a very good job in smoothing out peak load swings.

R. W. Sheffler: I would like to ask Mr. Orthwein about the 1500-kw pumpless rectifier. We have been rather hesitant to accept a pumpless rectifier of that large a size and we would like to ask if he carries any spare tanks for these rectifiers?

Also I notice on the 480-volt system he has rather an extensive tie-in whereby he can replace transformer capacity. I would like to look into the economics of this 480 tie-in as compared to the traditional transformer capacity close to the uses. I feel they put a lot of money into tie lines that is not used very much in an extensive 480 system.

R. G. Orthwein: With regard to the pumpless rectifiers, we have no record about failures. Both rectifiers are in service over a year and a half now and we do not carry any spare tanks, so far. However, as I said in my paper, the capacity of the installation is sufficient that they could operate with one rectifier in an emergency under present load conditions. With regard to spare tanks, we have been advised by the manufacturer that these are as readily available as vacuum tubes for smaller rectifiers.

As to the other question about the secondary ties between the 480-volt stations, it may seem like there is quite an expense involved. Actually there was not too much expense involved since the stations are not too far apart. The load is pretty much concentrated, the feeder system is underground through manholes, and the cables involved are comparatively short runs. Of course for a continuous mill, you can not afford to have transformer outage without having at least standby capacity in some way. It would have meant additional transformers to do away with tie circuits, which would have involved considerable greater expenditures, and besides, the transformers were not obtainable under the 1951 government material control system, without delaying starting operations of the mills.

Engineering Conception of Fairless Works

By J. D. ROLLINS

Assistant Vice President - Engineering, United States Steel Corp., Pittsburgh, Pa.

. . . . construction of the Fairless plant is an expression of faith in the future of American industry . . . .

▲ THIS discussion will provide some general background information about the Fairless Works, the reasons for its location and the reasons for its construction. As to location, the site of Fairless Works in Bucks County was chosen for a number of very important reasons. It is advantageously situated to serve a large and developing market for steel products. Within a 100-mile radius, there is a population of over 21,000,000 people — fourteen per cent of the total population of the United States. Within 300 miles up and down the Atlantic Seaboard is approximately one quarter of our country's total population, and a substantial proportion of the nation's total industrial capacity. Here is the center of manufacturing for tremendous quantities of consumer goods. Here are countless marketing opportunities for producers of basic materials.

The site of Fairless Works offered natural advantages as well. It has an abundant supply of fresh water which is vital. Raw materials and finished products can be transported to and from the plant by water, by excellent rail facilities, and by some of the finest highway routes in the eastern part of the United States.

Finally, there was the labor factor. We determined that the labor market in New Jersey and Pennsylvania, adjacent to Fairless Works, would be adequate for our requirements.

We began to study plans for an Eastern seaboard plant some years ago. Our original plans called for a finishing mill and, later, a blast furnace and five open hearths. The Korean War made it necessary for us to re-evaluate our plans. Construction had to begin immediately and it had to move fast. Instead of a single

The location of the Fairless Plant on the Delaware River provides low cost, water shipments of raw materials.

blast furnace, we would need two. Instead of five open hearths, we would need nine.

To complete a project of this size in as short a time as possible, we needed men and machinery. In addition to our own resources, we had to call upon the accumulated knowledge of the entire steel industry as well as many related enterprises. There were some 2000 odd contractors and subcontractors engaged. And that is only part of the story. These contractors and subcontractors purchased supplies and materials from 130,000 other business firms. Without the cooperation of this vast industrial network, the rapid construction of Fairless Works would not have been possible.

Fairless is an integrated steel mill with coke ovens, blast furnaces, open hearths, a 45-in. slabbing-blooming mill, an 80-in. hot strip mill, facilities for the production of hot and cold reduced sheets and tin plate, a 40-in. blooming mill, 30-in. billet mill, 21-in. billet mill, and a 10-in. bar mill in addition to the facilities of the National Tube Division.

A project of this kind requires a vast amount of engineering during the planning and construction stages. It has been said that engineering consumed 9,500,000 man-hours, and that is the equivalent of one engineer working about 4700 years.

The rare opportunity to "start from scratch" was one factor which influenced the design of Fairless Works. Most major expansions of the industry during the last 15 years have been limited by existing equipment or areas. This plant up the river had no such limitations. At first glance, the construction of such a plant would seem to be simply a matter of selecting the best equipment available and arranging it in the most efficient operating position. While this was true, more or less, some unusual problems did present themselves, and these problems had to be solved.

It may be of interest to mention some of the situations encountered prior to actual construction. The acquisition of land for something of this nature is too often taken for granted by the engineer. The 3800-acre site in Bucks County was an agricultural area devoted to general truck farming. This area was steeped in historical tradition dating back to the days of the Revolutionary War. Accumulating the many parcels of land was no easy task.

Preparation of the site itself was not too serious a problem. The flatness of the ground was a definite asset. The only things that needed moving were a few trees, fences and some old buildings. Many of the buildings, however, had historical significance. These were all carefully dismantled and such things as handmade bricks and wood paneling were contributed to the Pennsylvania Historical Society and to the architect responsible for the continuing restoration of George Washington's home at Mt. Vernon.

Our nearness to tidewater at Fairless Works is an economic asset, but it presented at least one major problem for the engineers. The original contour of the land ranged between 5 and 16 ft above mean water level. With a tidal rise and fall of some 7 ft, this would place the high point only 9 ft above high water. Proper drainage could not be achieved under these conditions. To alleviate this situation, nearly 9,000,000 cu yd of earth were removed from various locations of the site and used to fill other parts so that yard level in the plant now is 20 ft above mean low tidewater level. The result is that the physical appearance of Fairless Works at present, with its numerous borrow pits or lagoons, reminds one of Minnesota's "10,000 lakes." These borrow pits, however, offer a convenient disposal area for our slag.

Coke pushers discharge an oven about every six minutes from the two 87-oven coke batteries.

While usually there is nothing out of the ordinary in excavation work, we did at Fairless have a unique operation in constructing the vessel slip. It proved to be more economical to excavate the slip dry than to follow conventional practice of dredging. At present, the slip has a depth of 27 ft. The operation was accomplished by first driving sheet piling on two sides the length of the slip. Dewatering equipment was installed and excavation was begun, leaving a portion of the riverbank as a dike to protect the excavation.

Where permissible, conventional foundations, such as friction and bearing piles and concrete were used. However, foundation work at the Fairless Works did present two interesting problems. First, although soil conditions were generally good, the proximity of the plant to tidewater necessitated some means of resistance to hydraulic uplift. Second, when foundations were ready to be poured, much of the operating equipment had not been selected. Thus, no one knew exactly what size the foundations should be. Both of these situations were met with so-called "tub" foundations. These are simply large concrete boxes that "float" in the soil. By pouring these foundations at the same time, considerable savings were realized because dewatering equipment could be removed and any further work below ground water level was done inside the tub itself. When operating equipment was selected and installed, sub-foundations were built inside the tubs. As a result, there is adequate but not excess space available for comfortable operating.

Many of the buildings at Fairless Works are somewhat distinct. Conventional buildings have peaked roofs requiring snow breakers and gutters over the doorways. With these buildings, icicles and snow slides are major safety problems. Another difficulty is that overhead piping and cables have to be installed toward the center of the roof truss and when they cross from bay to bay, they must duck down under the eaves. The building knee braces also restrict crane operations.

At Fairless, many of these faults have been corrected. The roofs have very little pitch. By using a flat roof truss, no knee braces are needed, and this permits crane trolleys to travel a maximum distance. Gutters, built into the roof, reduce maintenance costs. With this type of construction, pipes and cables can run in both directions. They are kept near the columns for convenient and safe maintenance.

Another interesting feature of the buildings is the lack of windows. This eliminates the expense of cleaning and replacing glass. Of equal importance is the safety factor. By providing artificial lighting throughout, the light intensity is constant 24 hours a day, thus eliminating glare and shadows characteristic of so many of the older steel producing plants in the country.

Ventilation was not, of course, ignored. The buildings at Fairless Works are provided with sliding doors at ground level along the sides of the structure and continuous roof type and individual ventilators as needed for requirements.

Another interesting feature is the underground electrical grounding system. The soil conditions at Fairless Works were generally good from a construction viewpoint, but were very poor from a standpoint of resistance to underground corrosion. Most engineers are familiar with the practice of connecting bare copper cable to electrical equipment and steel structures. The cable is grounded to steel piling or ground beds of numerous, long copper rods which have been driven in groups.

The galvanic action from this method eventually results in failure of the cable and underground piping and weakening of the piling. In recent years, steel rods have been used instead of copper rods and the galvanic effect has been reduced but not eliminated.

At Fairless Works, we have installed a grounding system which, so far as we know, is the first of its kind ever used. The beds of steel rods have been improved by adding cathodic protection in the form of magnesium anodes within the beds. The underground piping is covered and connected to the ground beds and the lead-covered cable and ground wire are neoprene jacketed. This system provides for cathodic protection of the ground rods as well as the piping, piling, and underground cable.

We are using about 50 of these beds scattered throughout the plant with the number of rods and anodes varying from 23 to 100. Owing partially to the high soil resistivity encountered, the life expectancy for these anodes is about 20 years.

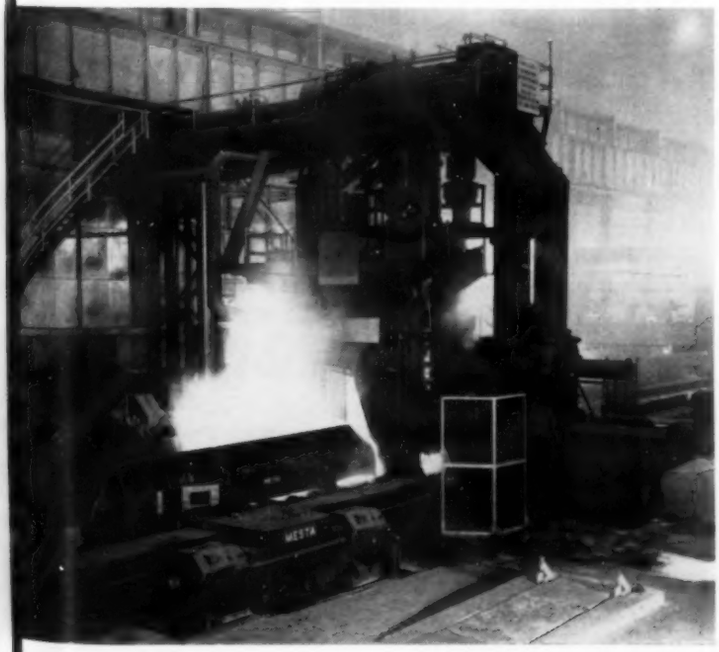
There is plenty of space at the Fairless Works. Sufficient space is allotted for efficient movement of raw materials, semifinished, and finished products. In addition to miles of broad gage railroad track and surfaced roadway, the plant is served by nearly a dozen conveyor belts for the handling and proper distribution of coal, coke, ore, limestone, and other basic raw materials. Perhaps the most publicized installation is the 48-in., 5500 ft long conveyor carrying furnace grade coke from the ovens to the blast furnaces. The advantages of such a handling method are manifold. The conveyor eliminates a number of railroad hopper cars and a locomotive or two to push them around. It eliminates a great portion of the breakage resulting from frequent loading and unloading. It contributes to the over-all safety of the plant. This conveyor, along with the others, eliminates a number of nuisance problems that have plagued good operation in the past.

The two blast furnaces are for the most part similar to most of the larger furnaces built in the past few years. There are, however, two items of interest, and the first of these are the iron ladles. We are using 200-ton torpedo ladles which are capable of retaining heat to the extent that the conventional hot metal mixers at the open hearth shop have been eliminated. Secondly, our situation has permitted modifications in slag handling. Slag is flushed from the furnace directly into dry pits where it is sprayed, cooled, removed by power shovel and trucked away as fill for the various borrow pits around the plant. This eliminates cinder pot cars and the costly job of hauling the slag to some distant dump.

Excepting the lack of hot metal mixers, the open hearth shop has little that is radically new. It is an accumulation of the latest equipment and operating ideas. As in other parts of the plant, the accent is on space for handling and smooth operations. There is one essential addition, however. Each furnace is equipped with a pair of electrostatic precipitators to remove the dust from the gas that would normally settle around the adjoining communities. The precipitators are three-stage units that deposit the dust in hoppers for subsequent vacuum removal and disposal.

The rolling mills are, like the open hearth shop,

A 16,000-hp reversing drive powers the 45-in. slabbing mill.



representative of the latest thinking of the industry. Naturally, since they are newer, the mills are bigger and faster, but operating principles are fundamentally the same as in other plants. The point of interest is the arrangement of the units. The ingot stripper building is located close to the soaking pits. Following the soaking pits is the 45-in. slabbing-blooming mill. Directly in line with the slabbing-blooming mill is the 80-in. hot strip mill. This arrangement, coupled with the bigger, faster 45-in. mill provides for by-passing the conventional reheating furnaces when rolling hot strip products, if so desired.

Sheet and tin facilities have not been neglected. Once again, there are no radical departures from convention. However, the 80-in. pickling line contains an innovation of some interest. The line is equipped with an 80-in., 2-high temper mill that breaks the oxide so that the steel can be pickled to a more uniform, high quality surface. This mill operates at speeds up to 600 fpm.

Another interesting point is the fact that the electrolytic tinning line is equipped for direct assorting, separating and packaging.

In addition to designing a steel plant capable of safely producing quality product at low cost, our engineers had still another job. We had the responsibility of designing facilities which would enable U. S. Steel Corp. to become a good neighbor in a new community. The problems of atmosphere pollution were recognized and something was done about them. Stream pollution was also given top attention.

The foregoing covers a few of the more interesting high points of the design and construction of the Fairless Works. This plant stands today as an example of high achievement in engineering. This new mill represents another link in the chain of this nation's defense against possible aggression, and a firm foundation for future prosperity in peaceful years ahead.

DISCUSSION

PRESENTED BY

LEO J. GOULD, Chief Engineer of Construction, Bethlehem Steel Co., Bethlehem, Pa.

J. D. ROLLINS, Assistant Vice President-Engineering, United States Steel Corp., Pittsburgh, Pa.

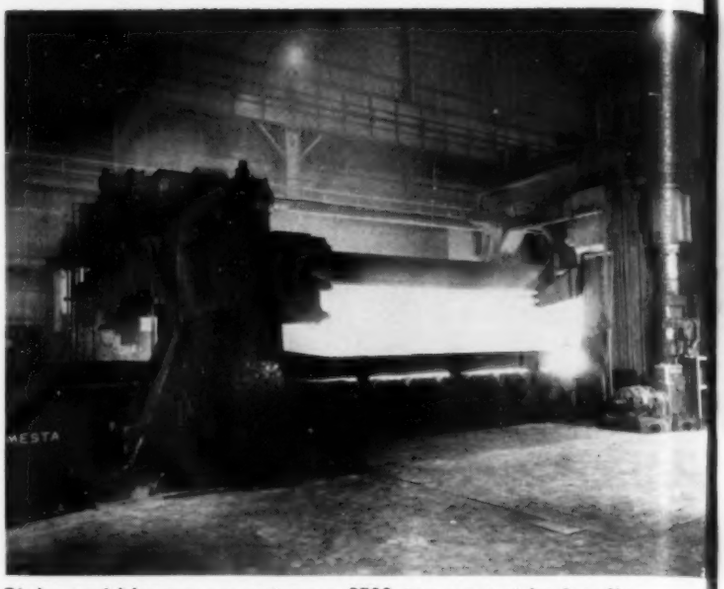
FRED H. JOHNSON, Assistant to Vice President in Charge of Steel Engineering, Inland Steel Co., Indiana Harbor Works, East Chicago, Ind.

STEPHEN VAJDA, Staff Engineer, Jones and Laughlin Steel Corp., Pittsburgh, Pa.

L. A. FUGASSI, Chief Draftsman, Weirton Steel Co., Weirton, W. Va.

Leo Gould: Since the official end of World War II the steel industry has expanded its production by 30 to 40 percent. A major portion of this increase was accomplished by men who are now gathered in this room.

Most of us did our parts by stretching existing facilities and fitting new facilities into existing plant where room was at a premium. The "shoe-horn" was more important than the slide rule. As we wondered if we could really get away with 6-in. greater diameter on an existing furnace or whether you really could persuade a railroad car to go around a radius of 150-ft, we dreamed of having the opportunity that Mr. Rollins and his associates had of starting on a clear site and really designing to make steel and not fit spaces. Most of us assumed the plant would be completely designed with equipment on order before contracting would start.



Slabs and blooms are cut on a 2500-ton up-cut hydraulic shear.

Obviously, Mr. Rollins good fortune did not extend this far. The tub foundations were an ingenious design to cover lack of data on the equipment that would be installed. As such they were better than our excavation diagrams. No other industry makes as much use of partial information as we do. In other words, only in the steel industry do we dig holes before we know what is going to go in them. Probably there were instances when there was some squirming around at Fairless to make some piece of equipment fit the tub.

There is one disadvantage to having the freedom to design without too many limitations. There are no alibis. The engineers are expected to produce a perfect plant. In the case of the Fairless plant they have done a job of which they can be proud.

We have been extremely interested in the papers published in various trade journals as the plant was built. We could imagine we were not putting two mills in a place barely large enough for one but spreading them out in the wide open spaces along the Delaware.

J. D. Rollins: I should like first to tell Mr. Gould that in constructing Fairless Works we too followed typical steel industry practice of using excavation diagrams. I will have to admit also that a few of them were not too good.

Fred H. Johnson: Many of us are interested in some specialized activity or process used in the steel plant. Very few have a chance to work on the complete project for converting raw materials into finished salable products. Mr. Rollins covered very well the many factors leading to the various decisions required. For instance, he covered the location of a particular site with respect to markets, the assembly of raw

materials, the availability of fresh water, location near tidewater, and the availability of labor. He mentioned the preliminary forward planning and compared the original plans and thinking to an accelerated program resulting from the Korean War.

I would like to have heard a little more about this phase of planning and the effect of the war on the project. Had there been sufficient forward planning to determine the final plan of the plant? Was it necessary to make many decisions in order to get going, similar to the happy one of using tub foundations?

We all realize the difficulties confronting the men when called upon to organize for this effort. I think it would be helpful if Mr. Rollins would comment on that phase. What was the extent of the engineering setup in Pittsburgh, and later at Fairless? How was the very extensive operating experience of the company brought into the picture? How many of the 4700 man-years were provided internally by the corporation and how many by contractors and consultants?

Many of us have already seen the results of this engineering effort at the Fairless Works, and we will welcome the opportunity to visit the plant to observe the unique features set out in his paper, particularly the arrangement and use of space for proper relationship of facilities, the material handling shortcuts, the model mill buildings, and the solution of the atmospheric pollution and stream pollution problems which can be a guide for all of us.

J. D. Rollins: In reply to Mr. Johnson's questions, I would like first to state that he is well aware of the preliminary planning for Fairless Works because he formerly worked with us in U. S. Steel. Certainly, the planning went on for many years prior to actual construction. We had many plans. Perhaps almost as many as we have engineers. As I mentioned previously, our initial thinking was for just a finishing plant and later we evolved the integrated plant including about 2,000,000 tons of ingot capacity. We had a group of top-flight engineers working for some time prior to actual construction and our ideas were crystallized as to the type of facilities we thought were needed to satisfy market requirements.

As to our engineering setup, we organized the construction engineering bureau within Central Operations which may be better remembered as Carnegie-Illinois Steel. This organization was expanded to some 600 engineers and draftsmen including field personnel. Further, we called on some 20-odd consulting firms who were recognized specialists in their fields. We took advantage of all of the "know-how" of suppliers, in fact, all of the "know-how" of the industry. I think all of you men here had a part directly or indirectly in the picture. Knowledge gleaned in such meetings as these, from contacts with engineers such as yourself, experience of our own engineers and the experience of our operating people were all combined in evolving the final plant design.

Stephen Vajda: It is the challenge of just such problems as enumerated in this paper which makes engineering the fascinating profession that it is. Naturally, because of the short time allotted him, Mr. Rollins could but briefly touch upon the many unusual engineering decisions made. As a result, he left many questions unanswered and, with his permission, I would like to make this discussion a small scale "Information Please" program. And so as not to lose the trend of thought, possibly he could answer each question as I ask it.

Aside from the hot and cold reduced sheets and tin plate what other products will be made?

J. D. Rollins: We have a bar mill which has a range of ⅜ to 2¼-in. rounds and equivalent and two continuous-weld pipe mills for standard pipe ½ to 4 in. in diameter. We also are able to produce semifinish in billet or slab form.

Stephen Vajda: Are there benzol and tar plants, or will the crude materials be shipped for refining?

J. D. Rollins: There are no benzol refining facilities. We recover tar but we do not distill tar. We also recover light oil which can either be sold to a processor or shipped to one of our other plants for recovery of benzol fractions.

Stephen Vajda: Much has been said about the 3800-acre site. What, if any, plans for the ultimate plant expansion dictated the purchase of such a large tract of land? For instance, does the river pump house have room for additional pumps, or must the building be enlarged?

J. D. Rollins: I think it is obvious that we have laid out the plant to allow for reasonable expansion. The site was purchased to give us considerable latitude in designing the plant. So far as the river pump house is concerned, that is typical of many such facilities. Arrangements are made for future expansion. When required, additional buildings as well as production facilities must be added.

Stephen Vajda: The so-called "tub foundation" are simply large concrete boxes that float in the soil. What thickness of concrete was used to prevent cracking? Were the tubs coated or surrounded by drain tile to prevent seepage? What was the average size of these "tubs"? Do you expect any movement from an excessively high water table? Are the building columns fastened to these tubs or are they on footers and piles of their own?

J. D. Rollins: The pads of the tubs vary in thickness depending upon the size and loads. They range from 3 to 5 ft in thickness. As to coatings, etc., our general practice was to first put down what we refer to as a mud slab which was nothing more than a 4-in. concrete slab poured directly on the mud. After that, we applied a membrane waterproofing followed by pouring of the structural concrete. Where required, we installed steel water stops.

As to design of the tubs, they were designed for 875 lb per sq ft of uplift when empty. There is no reason to expect any movement, whatsoever, because they were calculated so that as loaded with various sub-foundations, equipment, etc., the resultants of the forces approach the center of gravity. The 875-lb figure is equivalent to a 14-ft water table.

As to the average size of the tubs, they vary considerably. I think perhaps the largest was the one constructed for the four and five-stand cold reduction mills. That one is about 225 by some 600 ft.

The buildings' columns are integral with the tubs.

Stephen Vajda: You say the roofs have very little pitch. I assume these are built-up roofs. Was any special heat or fire resistant material used? Were any

precautions taken to help the escape of heat from under the roof in case of a fire?

J. D. Rollins: The roofs are of the built-up type. The material on the roof is fibre glass saturated with an asphalt material and gravel. There are no inflammable materials in the underside roof area. As to precaution for escape of heat, all buildings have roof ventilators.

Stephen Vajda: Another interesting feature of the buildings is the lack of windows. What type of lighting is used—mercury, fluorescent or incandescent? Is any attempt made to use "color harmonics" to brighten the buildings?

J. D. Rollins: With respect to the lighting, generally we used 50 per cent mercury vapor and 50 per cent incandescent type lights. The attempt was to duplicate the color of daylight and we believe it is very effective and comes about as close as you can get with artificial light.

As far as color harmonics, we have adopted this type of painting in selected areas but we did not spend the money to dress-up the entire plant.

Stephen Vajda: Another interesting feature is the underground electrical grounding system. Is there any salt water in the water table? What kind of coating is used on the underground piping? Is any special material used for backfill? Is there any pattern to the location of magnesium anodes? Is the distance to the material protected critical?

J. D. Rollins: As to the salt water, there is none. We have 100 per cent fresh water. The underground piping was first coated with a coal tar enamel and then wrapped with asbestos felt, saturated with the same coal tar enamel and finally painted with aluminum paint.

You asked about special backfill material. I assume you are referring to the anode beds. For 6 or 8 in. around the anodes, the backfill is bentonite, sodium sulphate and gypsum. For the rest of the area, selected dirt was used.

As to the pattern of locating magnesium anodes, there were two steel rods to each magnesium anode rod spaced alternately. The magnesium anode rod is in itself a steel rod on which magnesium has been cast for a distance of 10 ft.

You also asked is the distance critical. It just follows that the bed should be as close as you can get them to the area that is being grounded.

Stephen Vajda: You say the plant is served by nearly a dozen conveyor belts. What are some of the applications as pertaining to ore or limestone and especially the stock house of the blast furnace, if any?

J. D. Rollins: We previously mentioned that we get furnace coke by conveyor belt. We also have a 48 in. wide by some 3600 ft long conveyor belt running from the car dumper to the ore storage area for handling ore receipts by rail if there is ever need for it. This belt delivers into a conveyor system on which we handle waterborne ores.

We also have conveyors handling coal from car dumper to the stock as well as to the breaker building. By comparison as I recall, the smallest conveyor in the plant is 12 in. wide with the pulleys on 2 ft centers which is used for handling lime in the oil concentration plant.

Stephen Vajda: "Slag is flushed from the furnace into dry pits where it is sprayed, cooled, . . . etc." How far does the slag flow to get into the pits? What, if any, trouble is experienced with runner skulls? Is this a double pit in which the slag is cooling in one half while being removed from the other?

J. D. Rollins: The slag pit is a double pit. Slag flows about 100 to 150 ft to get into the pits. I know of no trouble we have had with runner skulls.

Stephen Vajda: Concerning the electrolytic tinning line, what kind of line is it; how fast? Do you do differential tinning?

J. D. Rollins: The electrolytic tinning line is a ferrostan line of U. S. Steel design. It is designed for a top speed of 1200 fpm and is equipped for differential coating of plate.

L. A. Fugassi: I am sure that every member of this association, who is actively engaged in engineering, has closely followed the progress of this enormous undertaking with great interest.

It is probably the ambition of every steel mill engineer to be associated with a completely new, integrated steel plant. However, this opportunity presents itself about once in five lifetimes. Those of us, not associated in such a program, sit back and dream how fine it would be to plan a new project, even just one single mill, and be able to fit it in without the use of the elastic shoehorn we all use. But as Mr. Rollins pointed out, installations such as Fairless are not done by a wave of the hand even though the beginning is on a large open area with no obstructions. The 9,500,000 manhours of engineering spent in planning alone would probably be lost in the total engineering manhours devoted to layout, design, and detail, not to mention the time spent by the real estate and financial people.

The modern thinking of the planning and design groups is certainly reflected in this installation and the only exactly typical thing that I noted was the installation of the sub-foundation before the operating equipment was selected. This, as you know, is standard steel mill practice and no doubt the thinking on your feet to finally tailor the foundation to the equipment is one of the main reasons the industry has such an excellent record for installing equipment in the shortest possible time.

The planning for the elimination of excessive handling of raw material and wastes will probably become the yardstick of the industry. The coke conveyor, the heat retention of the torpedo ladles, the slag handling, the open hearth precipitators and the disposal plants are the direct result of careful thinking.

The transformation of a peaceful farming area into an industrial giant, especially near one of our most historical cities, called for the best application of good neighbor policies. However, the corporation has always enjoyed the distinction of being a good neighbor. There is no doubt that the free-flow of ideas and information in the steel industry, which is, by far, more so than in any other industry, did materially aid in this project. The relationship of the companies with each other and with the suppliers of equipment is at the highest peak of any time in their history.

Mr. Rollins and his associates are to be congratulated for their excellent job and for the expression of their faith in the future of America.

Maintenance of Slag Bottom Soaking Pits

By JOHN A. WARCHOL, JR.
Supervisor, General Labor
Lukens Steel Co.
Coatesville, Pa.

. . . . by decreasing slag removal time, pit capacity is effectively increased . . . .

▲ PRODUCTION units are dependant upon auxiliary equipment for the necessary service which results in high rates of production. In the case of rolling mills producing steel plates, one of these auxiliary units is the soaking pit which heats the steel ingots to the required rolling temperature.

There are several designs of heating units, namely, continuous furnaces, side door furnaces, coke bottom soaking pits, and slag bottom soaking pits. This report will cover the maintenance of slag bottom soaking pits.

DESCRIPTION OF HEATING UNITS

The units at Lukens used for heating ingots to the proper rolling temperature vary in size and design. They will be designated as:

Type A—These pits are three-hole regenerative type pits. They are relatively shallow, measuring 7 ft from the top of the pit to the top of the bridgewall, and are 9 ft long and 9 ft wide. The slag depth is approximately 24 in. in a newly built pit and increases to approximately 30 in. as the refractory bottom decreases in thickness from several slag removal operations. The average volume of slag removed is 510 cu ft and the normal life is approximately 70 days.

Type B—This is a recuperative type pit measuring 9 ft 8 in. deep, 19 ft long, and 13 ft wide. The slag depth varies between 22 in. and 30 in., with an average volume of slag removed of 500 cu ft. The normal life of these pits is 90 days.

Type C—This is a recuperative type pit with two holes. Each hole measures 14 ft deep, 11 ft 10 in. long, and 10 ft 7 in. wide. The slag depth varies between 22 and 30 in., with an average of 550 cu ft of slag to be removed. The normal life of these pits is 75 days.

All three types of pits use natural gas as a fuel and heat rimming, killed, and high alloy steel ingots. The ingot sizes range from a 36 x 15-in. cross section to a 108 x 40-in. cross section. The height of the ingots varies from 40 to 120-in.

Contrary to a coke bottom soaking pit, none of the slag is flushed through the bottom of a slag bottom soaking pit. The slag accumulates in the bottom of the pit until it reaches a point where the pit must be shut down and the slag removed.

CONTROL OF SLAG ACCUMULATION

The life of a slag bottom soaking pit varies due to several factors, namely, type of steel, heating practice, and heating efficiency.

As mentioned previously, the steel heated is medium carbon rimming steel, killed steel, and high alloy or stainless steel. Each type has an effect on the rate at which a pit bottom fills with slag. Using the rimming steel as having a normal effect, it will be found that the pit heating high alloy ingots will have a longer life. The reverse, however, is true with pits heating killed ingots, because some of the slag is a result of the pieces of hot top refractory which is not cleaned off prior to being charged into the pit. This is particularly true where ingots are charged into the soaking pits immediately after leaving the open hearth and are too hot to properly condition.

It is well known that soaking ingots at high temperatures and for a long period of time will result in a heavier than normal jacket of scale. In addition, ingots which are heated to a wash heat, that is, the ingot surface is oxidized purposely to remove surface imperfections will result in excessive slag accumulation.

Thirdly, the oxidation of the steel ingot is affected by the operation of the pit or its heating efficiency. Units which have faulty checkers or recuperators require an excess of air to promote sufficient combustion

to heat the ingots. This practice is not common, however, such a condition will definitely affect the life of a pit.

There are probably few other factors, such as, spalling of the pit walls, refractories, etc., which also affect the pit life. All of these factors which tend to decrease pit life make it difficult to properly maintain a predetermined schedule of pit shutdowns for slag removal.

SCHEDULING OF PITS FOR SLAG REMOVAL

The sequence for scheduling pits off for slag removal is important and is controlled by two mediums: one, a comparison of the actual life of a pit against the expected life, and two a daily close inspection of the pits by the heating supervisor.

The normal life of a pit is considered as the average number of days a pit operates before becoming filled with slag. This figure is the result of data accumulated over a period of time under normal conditions, and is helpful in determining the approximate date the pit should go off for slag removal. Each week the heating supervisor makes out a report which shows the normal life and the expected life. He then must arrange a schedule for pit digging based on the expected life of all the pits and the actual condition of each pit.

PROCEDURE FOR REMOVING SLAG

The total down time of a pit is divided into two periods: one, cooling time, and two, slag removal time. As soon as a pit is emptied and the fuel is shut off, the slag is cooled with water. This is accomplished by using a spray made up of ordinary pipe made into a T. The bottom cross piece is closed at both ends and drilled at intervals to disperse the water. This watering not only cools the slag, but it also cracks the slag which makes it easier to cut with paving breakers.

After watering for 24 to 32 hours, depending upon the temperature of the pit, the slag removal operation begins. First the slag is broken with paving breakers, then it is lifted from the pit by a magnet. This operation is repeated until all the slag is removed. The personnel required for this operation is a six man crew. Three men work while the other three men, due to the heat, rest to spell off.

The elapsed time of the slag removal period ranges between 8 and 32 hours. This range of time is due to the conditions of the slag and the available crane service. With pits containing slag which is free of non-metallics, (type A) such as spalls from the pit walls and hot top refractory, and with crane service available as required, the slag can be removed in the minimum time. However, with non-metallics being present, the old method of manual shoveling must be employed. With reference to the manual method, it should be mentioned that prior to using the magnet, the down time of a pit was approximately 8 hours longer.

SUMMARY

In summarizing, it is evident that a considerable amount of time is required to fully complete the job of removing slag from a slag bottom soaking pit—from 32 to 64 hours. Although the use of the magnet has reduced this time, there is still a great deal of thought and experimentation required to reduce the overall time. First, the pit should be cooled faster or a method developed to afford working on the pit while still hot. Secondly, a faster method of breaking the slag or sectioning it should be developed to permit removal of large pieces.

In addition to decreasing the slag removal time, increasing the life of a pit will increase the heating capacity and reduce delays at the rolling mill.

DISCUSSION

PRESENTED BY

W. H. DAILEY, JR., Surface Combustion Corp., Toledo, Ohio.

R. C. WHITNEY, Vice President of Engineering, Amsler Morton Corp., Pittsburgh, Pa.

T. D. CLIFFORD, Superintendent, Slab and Strip Mills, United States Steel Corp., Fairless Works, Fairless Hills, Pa.

JOHN A. WARCHOL, JR., Supervisor, General Labor, Lukens Steel Co., Coatesville, Pa.

R. M. WEIGLE, Superintendent, Rolling Mills, Bethlehem Steel Co., Steelton, Pa.

E. C. HITE, Assistant Superintendent of Maintenance, Steel & Tube Division, Timken Roller Bearing Co., Canton, Ohio.

ALFRED KRAUSE, Manager, Rolling Mill, Steel Division, Ford Motor Co., Dearborn, Mich.

W. H. Dailey, Jr.: This is an interesting and timely paper on a subject about which relatively little is published. After reading Mr. Warchol's paper we made an analysis of the data available to us on the slag removal both for coke bottoms and slag bottoms in the latest designs of soaking pits. We find that it generally confirms the author's conclusions.

For slag bottoms we have found that under ideal conditions when heating clean alloy ingots to moderate rolling temperatures, and maintaining precise air-fuel ratio control, the time between cleanouts may be as long as 10 months. For the same installation, with other conditions the same, but with highly variable fuel supply which reduces the control over the air-fuel ratio, the time between cleanouts is only half as long.

Most recuperative pits use coke bottoms and here the time between cleanouts is also affected by the constituents of the ash in the coke, and by the compactness of the coke bed, in addition to the factors covered by the author.

For a specific coke, however, the bottom life is influenced by the same factors encountered with slag bottoms.

Under ideal conditions with clean ingots and accurate air-fuel ratio control, the bottom life between cleanouts may reach one year. While under poor conditions, with quantities of slag contributed from hot tops or from open hearth slag in open top molds, the life be-

tween cleanouts may be as short as seven days. The average is roughly 30 days.

Generally a two-man crew plus a crane can complete at least two bottoms in an eight-hour turn.

Coke bottom pits also require additions of coke at two or three day intervals to make up the losses due to combustion of the coke. This loss normally is about 0.4 lb per hr per sq ft, and varies with the permeability of the coke bed. It is largest for uniformly sized coke.

R. C. Whitney: Mr. Warchol has summarized his very excellent paper by suggesting that some study be given either to reducing the time necessary to remove the accumulated slag from the hearth of a soaking pit or to find some means for increasing the time between these bottom making operations.

We believe that substantial improvement has been made toward increasing the period between these operations. This desired result can be obtained, only by full development of the following three basic features:

1. A furnace whose inherent design is correct permitting the charge of steel to be brought to temperature uniformly without subjecting any portion of any ingot during this cycle to temperatures which will melt the previously formed scale or cause washing.
2. Satisfactory combustion so that at no time during the heating cycle will it be necessary to supply excessive quantities of air above those required for perfect combustion.
3. Two-way cover operation. This is often overlooked but is an important feature when dry bottoms are used. During the drawing operation, if excessive areas of the pit are uncovered, the scale on the ingots will be chilled and will, of course, contract. When the cover is again seated, a very high fuel flow will be needed to restore ingots to their control temperature. This high fuel flow will again heat the scale causing it to expand. This alternate contraction and expansion loosens the scale on the ingot, causing it to be readily dislodged when an ingot is gripped by the crane tongs for removal. With two-way cover operation, the area exposed during the drawing operation is held to a minimum, the chilling of the scale is greatly reduced and, consequently, the fuel flow after the cover has been reseated is correspondingly low. This eliminates the alternate contraction and expansion on the ingot scale resulting in a tight scale which is not dislodged when the ingot is removed from the pit.

We would like to give you a specific example of the results which can be obtained when all these features are present and where the hot top problem does not exist. This example represents one of the several soaking pit installations made in Europe in the last four years, where economic conditions dictate the use of dry bottoms.

On October 22, 1952, a two-hole row of soaking pits was placed in operation for Westfalenhuette at Westfalen, Germany. These pits measured 10 ft-6¾-in. x 17 ft-4¾-in. x 13 ft-5½-in. deep and were of the two-way top fired recuperative design.

At Christmas, 1953, after fourteen months of continuous operation, the entire plant was shut down for the Christmas holiday. During this shutdown period, these pits were examined and it was found that the total build-up on the hearth did not exceed 8-in.

Plants using worn out ingot stools, charging ingots with improperly removed hot tops, or leaning the ingots cannot hope to equal this performance. However, this shows what can be done when the undesirable features which increase the slag deposits have been eliminated and all features contributing to long life are developed to a high degree.

T. D. Clifford: What length of time is the pit out of heating operation? How long is the pit itself out of operation from the maintenance standpoint?

John A. Warchol, Jr.: As I stated, there are two periods. You have your cooling period and your actual slag removal period. The cooling is done by water, and it takes between 24 and 32 hours. Then we start digging the slag, and that will take anywhere from eight to 32 hours. So you have a total elapsed time of between 32 and 60 hours.

R. M. Weigle: I am wondering if Mr. Dailey will give us a little more information on his 0.4 lb of coke per hr per sq ft figure.

W. H. Dailey, Jr.: We obtained that figure from averaging data from several installations scattered pretty well over the country. Actually, our data shows wide variations. On several occasions we tried to measure coke consumption starting from the moment that it was added to the pit, but found it an impossible project with existing measuring devices. It appears to us that probably one-third of the total coke consumed is used up in the first hour after it is put into the pit. Accelerated consumption continues for at least the next four to eight hours. After that, for any given installation and particular kind of coke, the consumption rate remains nearly constant, and it probably is consumed in its stable state at maybe three-tenths of a pound per hour per square foot.

It does not seem to make a whole lot of difference if the excess air is high or low. Apparently an ash film forms in the first eight hours, and then if the bed is not disturbed very much, the consumption rate stays at the low value.

E. C. Hite: You indicate that you have slag depths of 20 to 24 inches at the time of cleaning the pits. Under normal operating conditions how much of this slag is in a molten condition?

John A. Warchol, Jr.: Very little, if any.

Member: I wonder if we can hear something about the difficulties of setting on these slag bottoms. Are they any more difficult than coke bottoms, or do you have storage or placing problems.

John A. Warchol, Jr.: I can not answer whether we have more or less than the coke bottom, but we do have some difficulty. We get filled up, and if your pit is not operating properly, you get hot spots. Naturally, you build up the slag in that hot spot. You either take the pit off or else you have wasted space in the pit. So we do have problems as far as spacing the ingots.

Alfred Krause: In these slag bottoms, with reference to masonry repairs that are necessary during these cleanouts, do you find that you have patching or repair work to any great degree?

John A. Warchol, Jr.: The bottom of the pit in our pits is constructed of basic brick, from the top of the pit bottom, that is, from the floor of the pit up to the bridge wall. After possibly four or five slag removal operations, we do have to replace this underpinning of basic brick.

Occasionally, the fellows get a little lax with the paving breaker, and they will take the brick out with it. So we do have some underpinning that is directly responsible or directly related to the slag removal.

But outside of the underpinning, and possibly a little bottom rebricking, I can not say that any other refractory maintenance is attributable to the slag removal operation.

Member: What material do they use after they clean the bottom out, to cover before they start the pit in operation?

John A. Warchol, Jr.: We do not use any particular material, the refractory bottom decreases in depth after several slag removal operations. When it gets down to the point where it is getting near the pan plates, then the entire bottom is rebricked. There is no special preparation after each slag removal.

Member: I might say that in our operation we have about 12 or 16 bottom-fired Morton pits, and we use a light layer of coke breeze (two or three inches); we use coke magnesite, and it effects much easier removal of slag.

John A. Warchol, Jr.: I can probably understand that. It does not stick to your bottom.

Member: Since you do take these pits down to comparatively low temperature with relative frequency, as compared to the eventual life of the recuperator, have you found that that constant cooling down and heating up has any tendency to reduce the overall life of the recuperator?

Secondly, I would like to inquire what is your heating-up time after you have effected removal of the slag?

Third, since you do not have a bottom in there, and you build up several feet of depth eventually, when you start with a new pit and put ingots in, do you ever run into any tendency for cold butts due to the relative height of the butt from the pit bottom?

John A. Warchol, Jr.: With regard to the effect of the cooling on the recuperator, we have not found any detrimental effect. You definitely have to be careful when you are cooling with water that you do not get water down into the recuperator, or a great volume of steam.

On the heating-up process after the slag is removed, that is relatively fast. It is between eight and 12 hours.

Member: When you start with a bottom after it has been dug out, as I understand it, the depth of the bottom of your ingot will be lower than it is after the slag has built up several feet. Do you have any tendency to run into cold butts at that time? In other words, due to the relative position of the ingot, it is more difficult to get the butt up to the proper temperature?

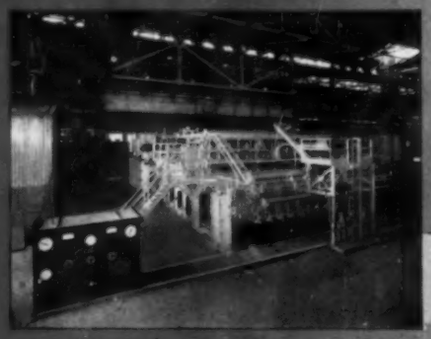
John A. Warchol, Jr.: Not to my knowledge. I have not heard of any such difficulties.

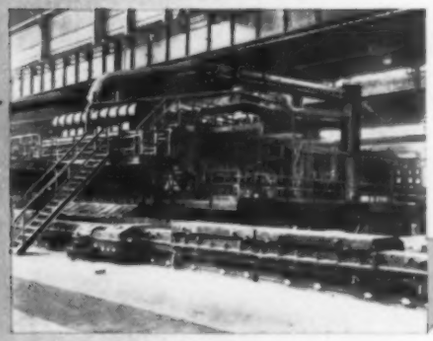
AISE SPRING CONFERENCE

APRIL 25, 26, 27, 1955

HOTEL STATLER DETROIT, MICH.

LOOK TO RUST FOR FURNACE EFFICIENCY





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CARPENTER STEEL INSTALLS MULTI-PURPOSE HOT ROLLING MILL

▲ THE Carpenter Steel Co. of Reading, Pa., has put into operation a new hot rolling mill which makes possible the production of strip, rods and bars on one combined mill layout. The new mill was specially designed and laid out to meet all the exacting requirements involved in producing a wide range of specialty steel products, including tool, stainless and alloy steels. A monthly production of 3500 tons of specialty steels is expected.

Besides offering a unique production flexibility, the multi-purpose mill incorporates improved heating facilities that aid in controlling surface decarburization. All reheating furnaces—both continuous and batch type—are oil-fired and equipped with automatic controls. From the continuous furnace, the heated steel is discharged directly on to the approach table of the mill. The batch furnaces are served by a mobile truck equipped with manipulator tongs.

The mill contains a total of 24 stands. Heated steel from the furnaces is first roughed in a 20-in. reversing mill. If the product is to be strip, the break-down from the 20-in. mill proceeds straight ahead through a 14-in. strip mill consisting of six two-high stands and one edger.

If the product is to be bars or rods, break-downs from the 20-in. mill are moved laterally to a three-high 18-in. mill equipped with tilting tables.

From the 18-in. mill, the steel proceeds to a 12-in. mill consisting of one 14-in. stand and four 12-in. stands sitting roughly side by side and arranged for either cross-country rolling or looping.

For still smaller sizes, there are eleven 10-in. stands arranged for looping.

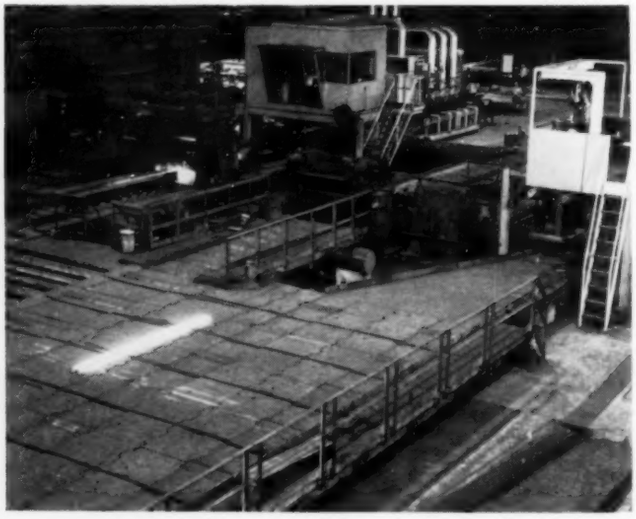
The unique layout of the mill enables the company to substantially reduce downtime during roll changes. Facilities are so arranged that rolls can be changed in one part of the mill while operations continue uninterrupted on other stands. This saving in downtime affords an unusual flexibility in the handling of many different grades and sizes of steel. It is particularly important in handling the multitude of small orders (from 1000 to 15,000 lb) which are so typical of the specialty mill output.

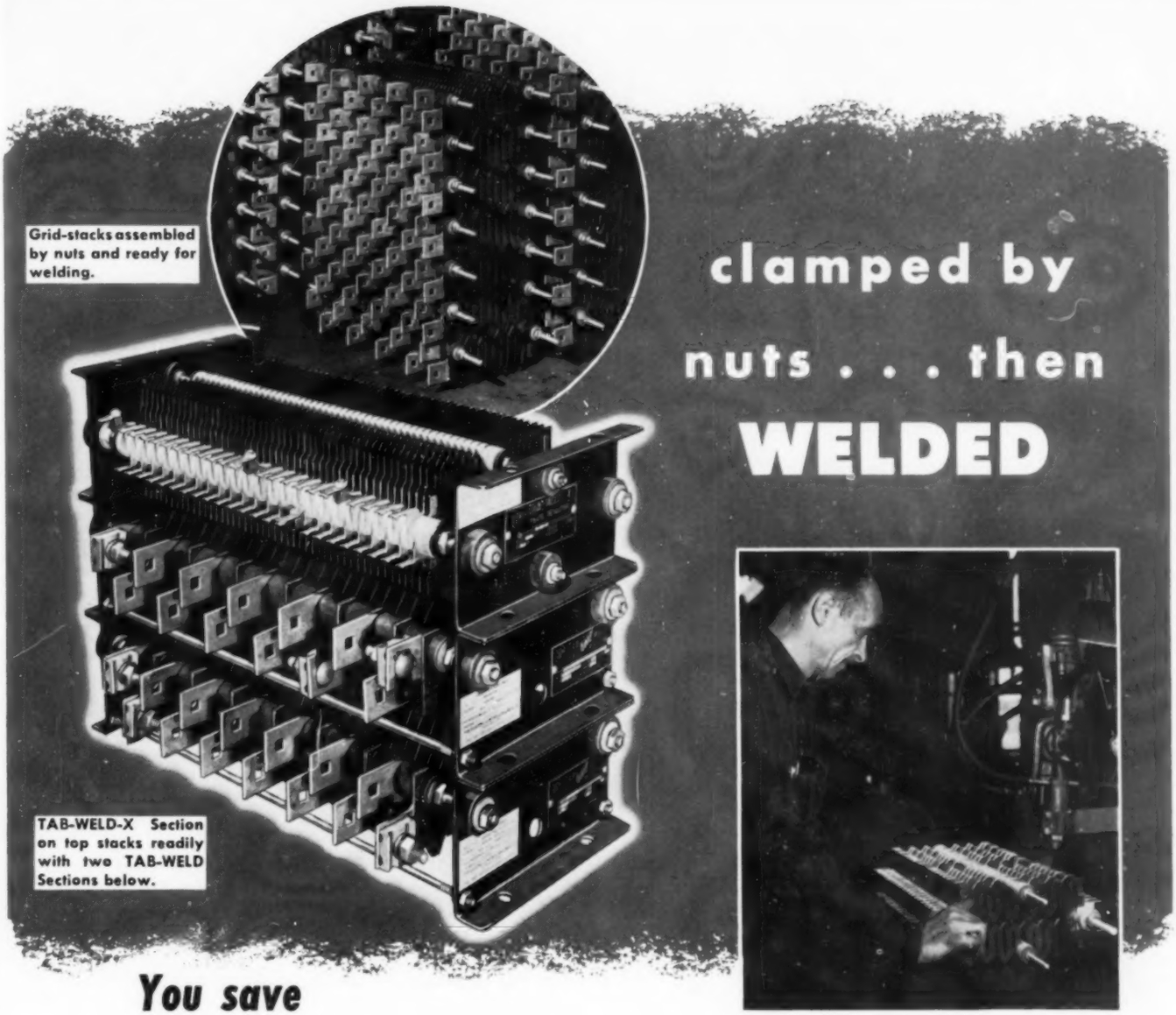
The mill can deliver out of No. 7 stand of the strip train, out of No. 5 stand of the 12-in. mill, or out of stands 5, 7, 9-F or 14 of the 10-in. mill.

Product leaving the mill can take one of three courses. From the strip mill, strip is put through an oscillating

A view of the rolling area from the starting end of the mill. Batch furnaces are on the left, continuous furnace on the right.

The 20-in. reversing mill at upper left is used for the initial breakdown passes. The 18-in. stand in the center completes the roughing for bars and rod.




Grid-stacks assembled by nuts and ready for welding.
TAB-WELD-X Section on top stacks readily with two TAB-WELD Sections below.

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EC&M BULLETIN

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U-TS

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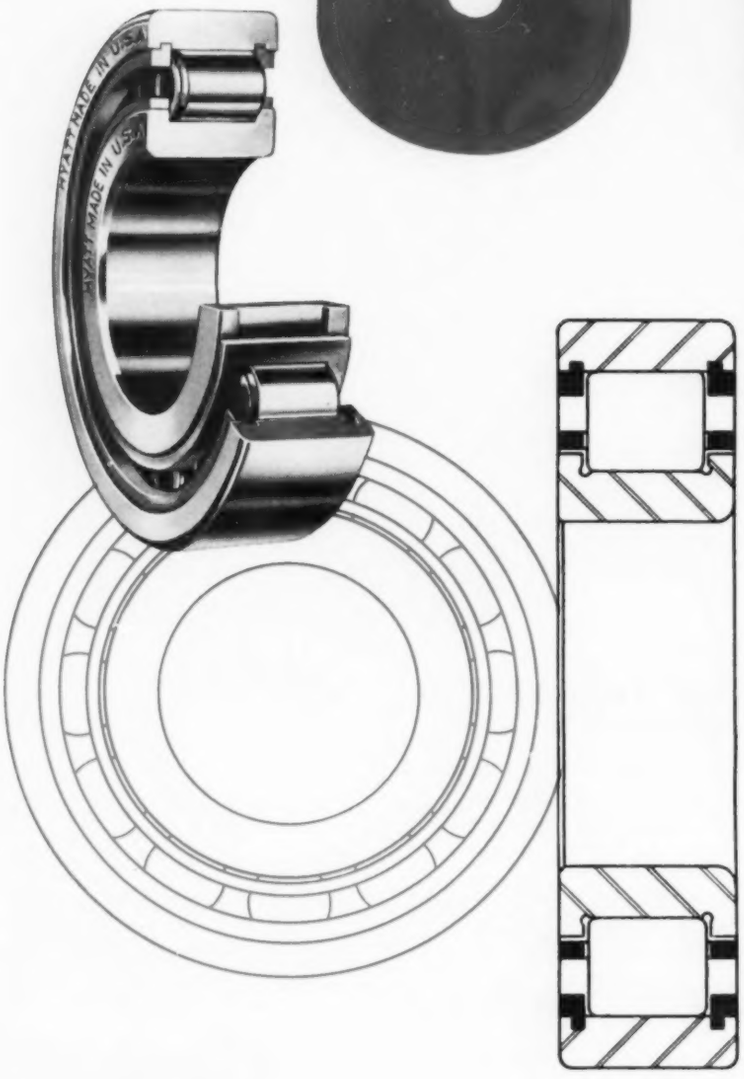

U indicates inner race flanged at both ends

T indicates outer race has 2 retaining rings

S indicates rollers spaced circumferentially by separator

This non-separable Hyatt U-TS is widely utilized for applications where: (1) no provision is made to retain the outer race endwise, or (2) the bearing must be assembled as a unit. It is available in the 1200, 1300, 5200 and 5300 series.

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HYATT

ROLLER BEARINGS

STRAIGHT BARREL TAPER

DIVISION OF GENERAL MOTORS CORPORATION

This view of the strip mill shows one length of strip being rolled, while the reversing breakdown mill at upper right is preparing the next slab for rolling.

This view shows the continuous looping method used to roll rods. Various stands of the 10-in. mill are in the foreground, and the roughing stands are in the background.

An overall view of the center bay from the finishing end of the mill, showing the various finishing points: the notched bar cooling bed at bottom right, the reels and coil conveyor in the center, and the strip cooling table at the left.

feeder and placed on edge on a cooling table, then coiled. Bars proceed straight ahead to a notched-bar cooling bed. Small sections can be led to either of two reels.

The mill is designed to roll strip from ½ in. to 10 in. wide to a minimum thickness of 0.093 in.; coiled rod stock ¼ - 5/16 in. in diameter; and bars ⅜ - 1½ in. in diameter. In addition, ingots up to 14 in. square may be roughed down on the 20-in. stand into billets or slabs for re-rolling. Production rates of 15 tons per hr on strip, 11 tons per hr on small rounds and 6 or 7 tons per hr on ¼-in. rod are attained.

The mill stands are individually driven. Electric power for the main mill drives is supplied by motor-generator sets. Auxiliary d-c power is provided by a mercury arc rectifier.

Lubrication of the mill is accomplished by three central oil systems and two smaller systems, and by 15 grease systems.

To provide smooth, clean surfaces on the hot rolled product, a high-pressure water spray descaling system is provided.

The mill is housed in a building 190 ft wide × 650 ft long, built of brick and corrugated asbestos siding. It consists of three separate bays, the 90-ft central bay housing the mill equipment and two 50-ft side bays housing motors, auxiliary equipment, and facilities for quality control inspection and for maintenance. To facilitate operation and maintain steady production, a two-way communication system is provided in this building, whereby any man at any operating pulpit can transmit a message that will be heard throughout the mill.

The building is lighted by mercury vapor lamps in conjunction with auxiliary incandescent lamps. Lighting intensity ranges 20-40 foot-candles, depending on the type of work performed.

Water is provided by a 1500-gpm recirculating system containing settling basins. Scale from the mill is washed into one of these basins, where it settles out. The clear water overflows into a second basin and is then pumped back into the system.

This is the main motor room showing a row of 850-hp mill motors at the right, and electrical control panels at the left. The room is ventilated by recirculated air which is cleaned and cooled.

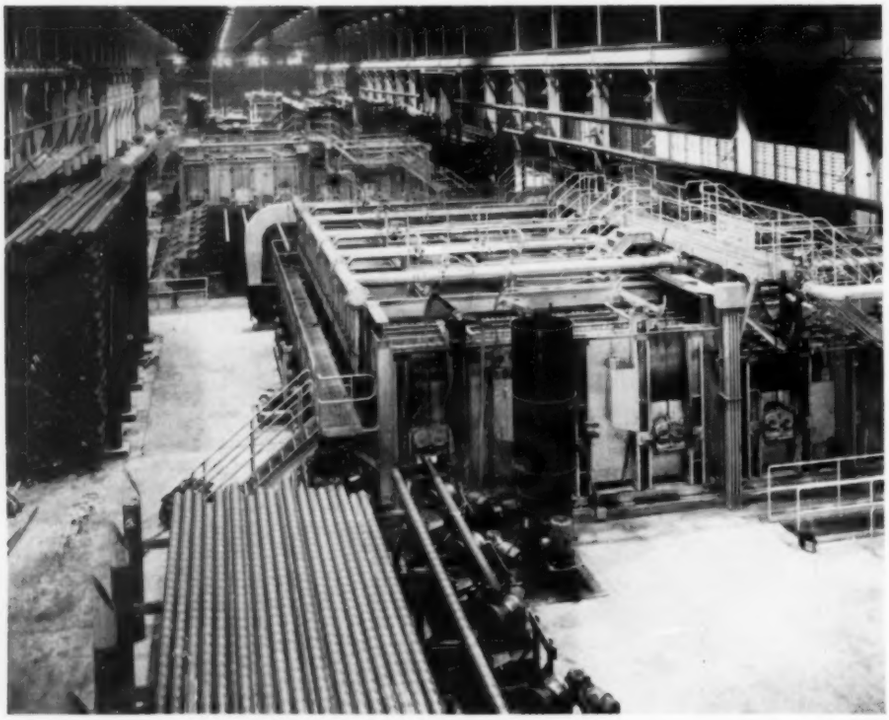
J&L Adds Facilities to Tube Department

▲ NEW finishing facilities for producing oil country tubular products in the high strengths necessary for deep drilling are now in operation at Jones & Laughlin Steel Corp.'s Aliquippa Works.

The new facilities make up an addition to J&L's seamless tube department costing $4,700,000. They are housed in a new 100 × 725 ft steel structure with corrugated siding, built north and west of the 30-in. seamless round mill and seamless tube mill buildings.

The new structure, called the "Seamless Tube Specialties Department," is the first step in expansion of facilities for finishing high strength and special seamless tube products used in the oil industry. Further expansion of these facilities will come under J&L's plans for a $51,000,000 expenditure on this project and other projects in 1955.

Figure 1 — Overall view of the seamless tube specialties department at Jones & Laughlin Steel Corp.'s Aliquippa, Pa., plant. High strength seamless steel pipe progresses automatically from the feed table in the foreground, through the heat treating furnaces in the center of the picture and into straightening, cutting and threading machines, not visible in this picture.



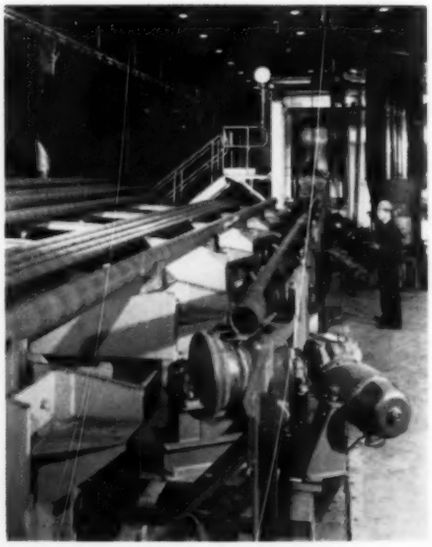


Figure 2 — Seamless pipe of 7-in. outside diameter for oil well casing is going into the No. 1 high temperature heat treating furnace for normalizing.

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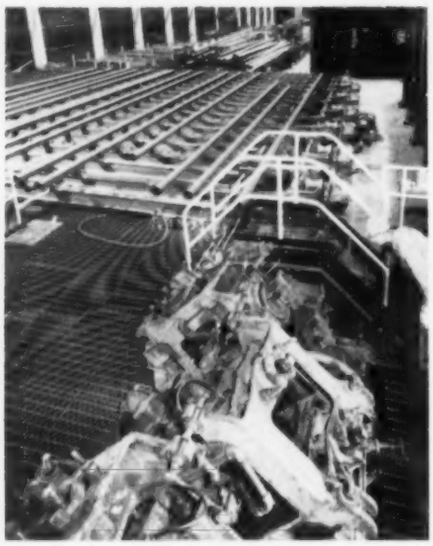


Figure 3 — The three-stand reducing mill, foreground, at the exit end of the No. 2 tempering furnace, sizes the pipe to exact diameter. The No. 2 cooling bed in the upper left quarter of the picture moves and assembles the pipe for further processing.

In the new specialties department, equipment of J&L design makes possible finishing of seamless oil country casing and tubing by quench and temper heat treatment, imparting to these products characteristics that formerly were attained through adjustments in the chemical composition of the steel.

By speeding up and improving the finishing facilities, the new installation will tend to increase the total output of J&L high-strength seamless pipe.

The new process also will result in savings of many tons annually of alloying materials—manganese, molybdenum and chromium—formerly used in steels for high strength seamless pipe.

The heat-treating equipment consists of two hearth-type mechanically-operated gas-fired furnaces, with a water-spray quenching unit between them. One furnace is a high-temperature furnace. The other is a tempering furnace.

Processing of the various products may involve normalizing, or normalizing and tempering, of alloy steels; or quenching and tempering of plain carbon steels.

The seamless pipe, produced in the existing mills, will come to the new department on new 15-ton side-operated lift trucks. When normalizing, the pipe passes through the high temperature furnace. By controlled heating and cooling through the transformation range of the steel, the grain structure is refined and made uniform. When quenching, the pipe is first heated in the high temperature furnace above the upper transformation temperature. Then it passes through the quenching unit, where it is water-sprayed with high-pressure injector-type nozzles. Quenching hardens the steel.

Then the pipe passes through the tempering furnace to restore the desired degree of ductility and toughness.

The hearth-type furnaces and the quenching unit are unique with J&L. Furnaces of this design provide uniform and efficient heating, and are able to process a wide variety of tubular products.

In the J&L-designed quenching unit, the pipe passes longitudinally through radially-directed water sprays, giving a more effective quenching action. This has been accomplished by lengthening the quenching unit, making it possible to run the pipe through at greater speeds.

Other equipment in the new building consists of a three-stand sizing mill for sizing the pipe to exact diameter; a rotary straightener; a gag-press straightener; cut-off and threading equipment for final finishing operations; pipe storage racks, fuel oil storage tanks, and an office.

A 6900-volt power line and substation building provide 60-cycle power to the new operations. The facilities were installed because of oil country demands for an increasing proportion of high-strength pipe.

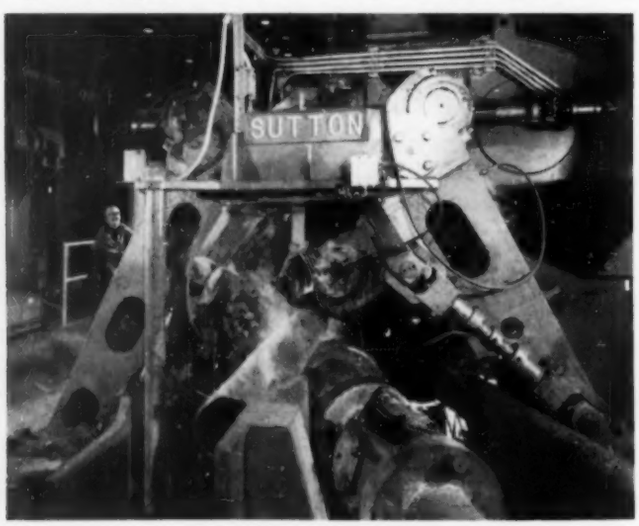
Deepest producing well is Richfield Oil Corp.'s 67-29 Coles Levee A in North Coles Levee Field, Kern County, Calif. The well was completed in December 1953, for 119 barrels a day from a producing zone between 17,500 and 17,892 ft.

New well drillings in the first six months of 1954 were 8 per cent ahead of 1953, with 25,130 wells being sunk from January 1 to June 30. Oilmen expect the year's total to exceed 50,000 wells. Average depth of wells has increased steadily over the past 11 years to over 4000 ft.

Because of the trend to deeper wells, and because of extraordinary requirements in off-shore drilling, the drilling industry now requires grades for oil country tubular goods with minimum yield strengths as high as 110,000 lb per sq. in.

Figure 4 (below) — Exit end of large rotary straightening machine.

Figure 5 (right) — Interior of high temperature 1650 F furnace. The pipe moves through slowly from left to right on the conveyorized furnace bottom passing out the exit door in the background.



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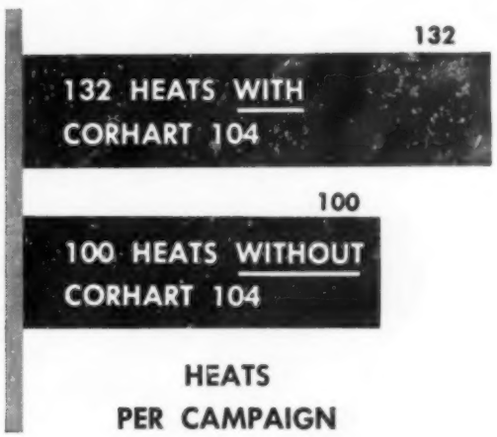

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On the following seven campaigns, this furnace racked up 32% more heats over its previous average — produced an average of 2,400 extra tons of steel per campaign — reduced downtime for patching by 12%.

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INSTRUMENTATION AT FAIRLESS WORKS

By H. L. RUSSELL
Instrumentation Engineer

and

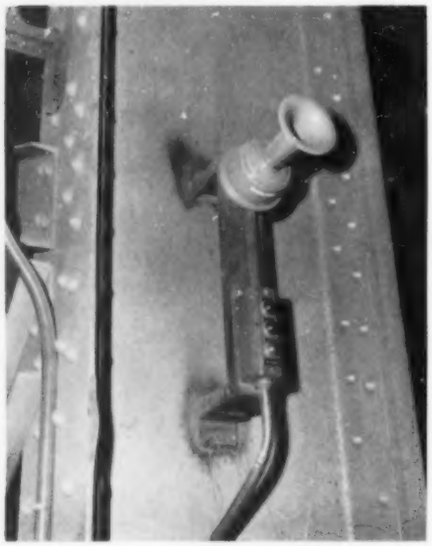
F. R. ROSS
Project Engineer

Industrial Div.
Minneapolis-Honeywell Regulator Co.
Philadelphia, Pa.

▲ BY any industrial yardstick the steelmaking facilities at U. S. Steel's gigantic Fairless Works on a 3800-acre site in Fairless Hills, Pa. comprise one of the largest, most comprehensive production operations found anywhere. Inside the plant area 75 miles of railroad track and 20 miles of roads link the various sections of the huge plant. The $450,000,000 plant, generally regarded as one of the largest integrated steel mills ever built, also reflects the growing trend toward automation in the steel industry.

The broad utilization of industrial process control equipment represents what years of experience and engineering analysis have indicated to be the most efficient degree of instrumentation, including the best selection of pyrometers, gages, timers, controllers, thermocouples and radiation pickups.

Figure 1 — Colored lights and horn extend thermocouple life in open hearth department.



The blast furnaces and open hearths are capable of turning out 1,800,000 tons of steel a year. Each of the nine steelmaking furnaces has a capacity of about 300 tons per heat. Oil or tar or a combination of the two is burned to provide heat for converting iron to steel. Each furnace has its own set of instruments mounted on a clean, light-colored, illuminated control panel.

Automatic furnace reversal—Instrumentation at Fairless gives a choice of three methods for furnace reversal. The manual method of operation allows reversal at any time. A time-schedule method, usually employed only when a furnace is warming up, reverses the furnace periodically. The most useful and most used mode is a combined time and temperature difference schedule.

For time and temperature difference control an electronic circular scale controller, designed by Minneapolis-Honeywell's Industrial Division, and a timer are used. Before one set of checkers becomes too hot or cool, as compared to the other set, the flows of incoming air and burned gases are reversed by the temperature difference controller. Also, even if the required temperature difference does not develop, the timer will reverse the flow after a specific period, to equalize the reactions in various zones of the furnace.

Figure 2 — Instrument with dual-range circuit records molten steel temperatures.

Checker temperatures are sensed by air-cooled radiamatic radiation detection devices, four in each furnace, mounted in the sidewalls. Besides furnishing signals for the temperature difference controller, any pair of units can be connected to a strip chart recorder through a selector switch. The strip chart is pencil marked from time to time to show which wall temperature is being recorded. To protect open hearth furnace roofs against overheating, roof

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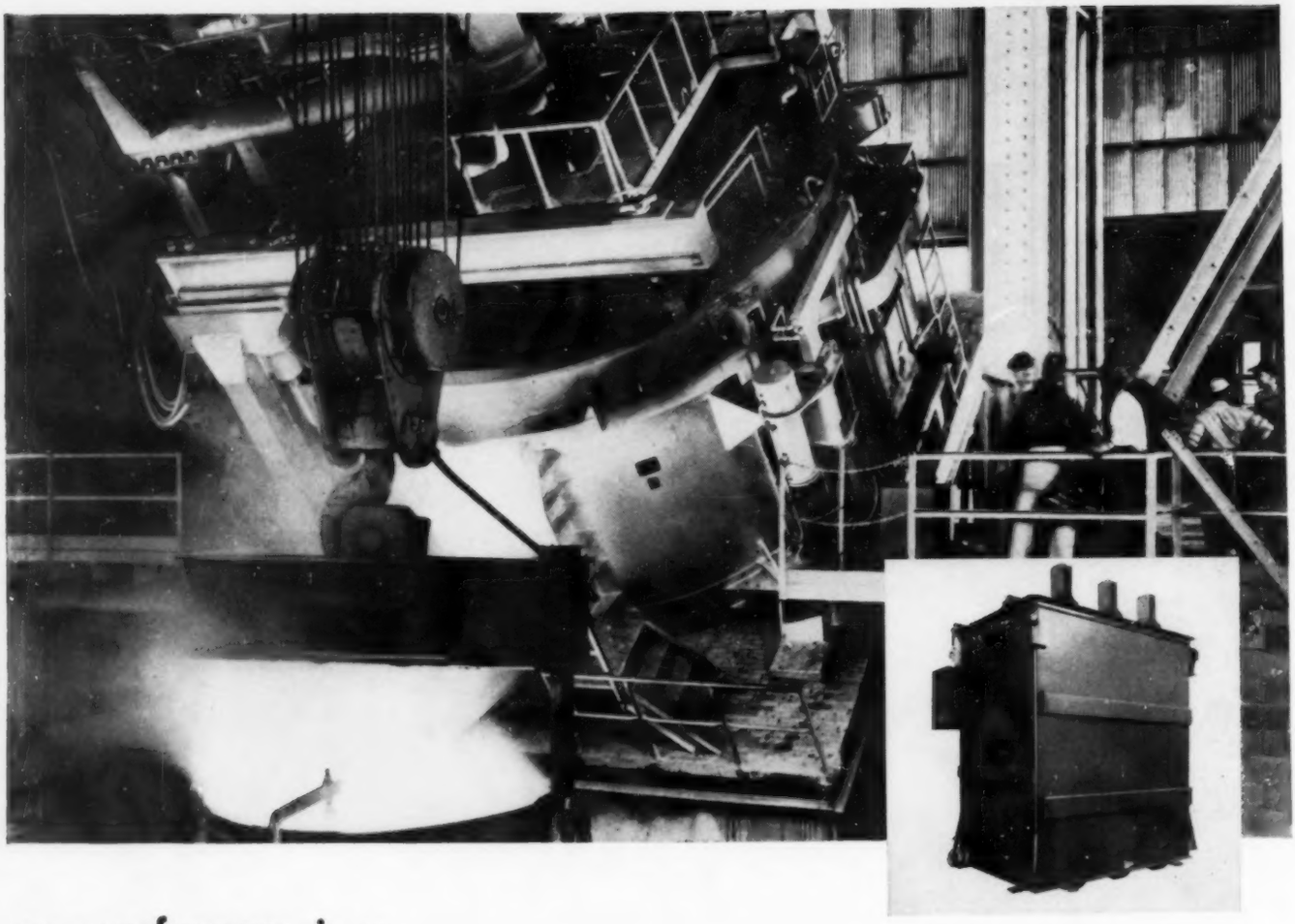

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Figure 3 — Air-cooled radiamatic detector sights checker temperature.

temperature is limited with a radiamatic detector and a circular scale controller.

Signal unit saves thermocouples — Molten steel temperatures are checked with immersion thermocouples specially constructed by U. S. Steel. These thermocouples are used with the Brown bath temperature signaling and recording system. Periodic checks of metal temperature ensure against hot and cold heats, reduce skulls and stool stickers, and also increase mold and ladle life. The Brown system expedites these desirable temperature measurements and at the same time prolongs thermocouple life and minimizes physical effort and confusion.

An electronic strip chart recorder with automatic standardization and special double-range scale is the heart of the system. However, the associated signal light and horn unit receives primary attention during actual measurements. This three-light-and-horn assembly is mounted high on a central pillar, where it can be seen from the furnace area despite crane movements and other floor obstructions. The signal lights eliminate the need for shouting and vague arm signals when two men are working together. Or, if the thermocouple user were working alone, without the aid of these signals, he would have to walk several hundred feet from the furnace to the panelboard to read temperatures, and the thermocouple would deteriorate rapidly in the time it took him to walk there and back.

At the start of a typical temperature reading operation, a green light both proves the continuity and polarity of the thermocouple and also shows that the instrument has standardized. The left end of the instrument scale is graduated from —50 to 150 F, but the chart does not move while the pen is in this range. After noting the green light, the operator places the thermocouple in the metal, or near the wicket hole when preheating is desired.

From 150 F to 2300 F, the instrument switches back and forth between low and high range, causing an orange light to flash and the chart to move intermittently. From 2300 F up, the chart motor runs at normal speed and the orange light stays on. The thermocouple can now be immersed if this was not previously done. When the temperature reading levels off, showing that the thermocouple is measuring the steel temperature, a red light goes on and a horn sounds, to warn that the thermocouple should be withdrawn at once. As soon as the thermocouple is disconnected, the pen returns to zero, and the chart motor stops.

During the entire operation, the operator stays near the furnace and is guided by the colored signal lights. Thermocouple life is extended, because the thermocouple stays in the molten steel only as long as needed to get a reading. The electronic instrument, using only a few inches of chart paper, makes a complete, accurate record of the steel temperature.

Recuperative soaking pit furnaces — At the Fairless Works, two-way, top-fired, recuperative type Loftus soaking pit furnaces are used. Coke oven gas is the usual fuel, though provisions are made to supplement it with natural gas when necessary.

Waste gases leave the furnace through the bottom and are blown through the recuperator tubes, while incoming air is heated during three horizontal passes around these tubes. Two type R (platinum, platinum-13 per cent rhodium) thermocouples (mounted at opposite sides) are installed in each pit. The operator switches the hotter thermocouple into the control system.

Temperature control instrumentation utilizes a Brown strip chart controller, with Electr-O-Line relay, to secure several objectives. Maintenance of pit temperature at the desired level is the primary aim. A secondary feature is waste gas recirculation.

As the pit temperature comes up to the control point and the fuel flow is cut back, hot waste gases are recirculated in conjunction with the fuel gas to maintain a relatively constant volume of gases flowing through the pit. This results in better heat distribution, increased utilization of

Figure 4 — Two indices on soaking pit instrument permit controlled heat acceleration cycles.

combustion heat and a shortened soaking time.

Recirculation of gases occurs when the operator switches a manual reset relay into the system. Then, when the fuel gas butterfly starts to close because of reduced demand, a retransmitting slide wire on the electric

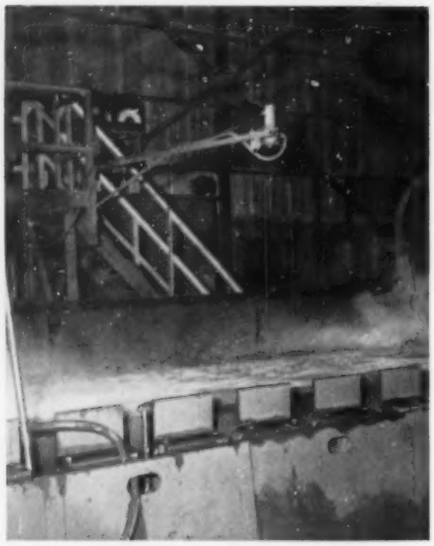


Figure 5 — Hot rolled strip runs under temperature detecting radiamatic unit.

motor operator of the gas valve causes a waste gas butterfly to open proportionally over a 30 per cent band until it is wide open.

Heat acceleration is a feature of the soaking pit instrumentation that permits temporarily raising pit temperature to a higher-than-normal limit for the purpose of heating ingots more quickly. The electronic controller has two indices which are normally set about 50 degrees apart. During normal operations, temperature is held at the lower index.

To initiate heat acceleration, the operator sets a timer for the wanted length of the cycle, and then pushes a button. Immediately the fuel gas valve is driven wide open and the upper index takes control. At the end of the timed cycle, control reverts to the lower index. The gas valves are operated by electric motors.

Strip mill chart records — The continuous strip mill is an impressively long building and, inside, hot slabs and strip race over the conveyor at speeds up to 2300 fpm. At each rolling mill, a radiation detector sights on the passing strip and the temperature registers on an adjacent strip chart recorder for the guidance of the mill operators. The recorders are specially equipped with calibrating rheostats that are adjusted to compensate for emissivity and the effects of the spray and steam associated with high-speed rolling.

These temperature records are duplicated on five strip chart recorders near the end of the conveyor line. The charts store valuable information for metallurgists concerned with the effect of rolling temperature on grain structure elongation and other physical properties.

Batch annealing — Each annealing furnace contains 20 radiant tube burners and is fired with coke oven or natural gas. Temperature of each furnace is controlled by a type J (iron-constantan) thermocouple, an electronic strip chart controller and a Beck relay, mounted on the back end of the furnace. Another thermocouple, installed on the front, is used for checking and comparison.

There are 11 furnaces to serve 27 stack areas. Each stack area consists of a line of four special ring-shaped pedestals. Coils to be annealed are stacked three high on these pedestals, protective steel shells are lowered over the stacked coils and then a furnace is placed over the four protected stacks for the 36 to 72 hours needed for annealing.

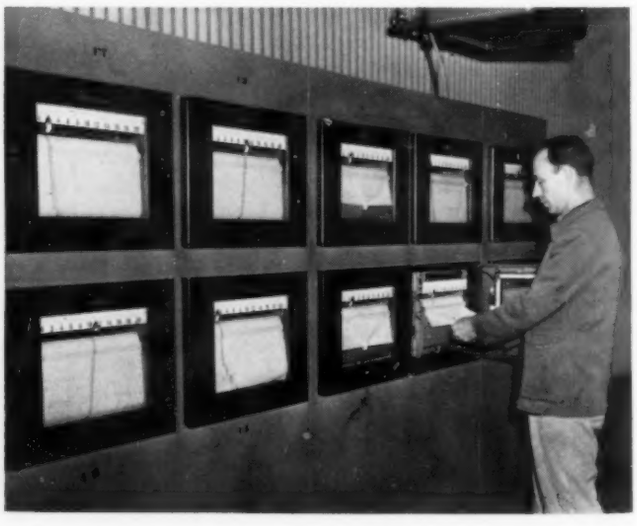
Processing time depends on the furnace temperature at start of annealing, on the load, on the metal gage and the type of finish desired. During annealing, an inert atmosphere of HNX gas is fed into the protective shell to protect the heated coils from scaling and oxidation.

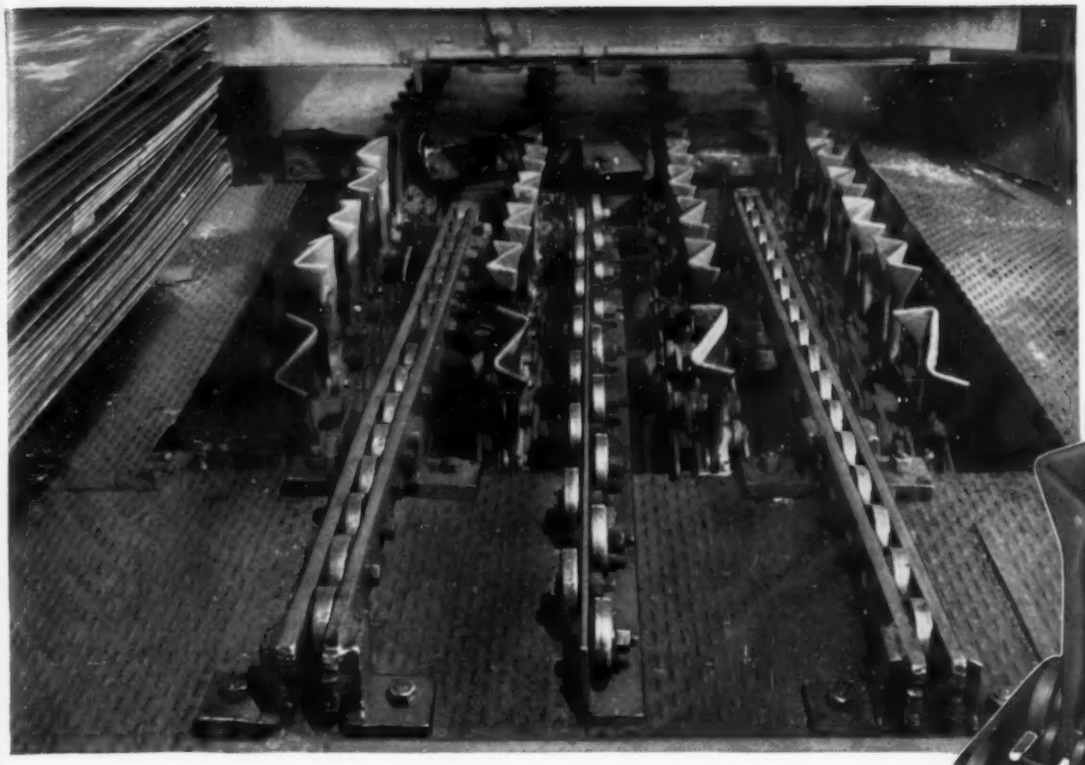
There is a thermocouple permanently mounted in the metal pedestal that supports each stack. Another thermocouple is placed on top of one stack in a group of four. These five thermocouples connect to one of the 27 multiple-record strip chart recorders grouped in side rooms. An operator looking over the charts can see both the time and temperature record of all the annealing operations and thus can know when each quartet of stacks has undergone the required processing. Although the furnace is lifted off as soon as annealing is complete, the inner shell, holding the HNX gas, is left in place until the coils have lost most of their heat. For fast cooling, air from the pressurized cellar is allowed to flow over the covered stacks.

Instrumentation and automatic controls, as harnessed at Fairless, play a vital role in standardizing quality, maintaining fuel economy and guiding processes and workers.

Figure 6 — A bank of five recorders gather rolling process data.

Figure 7 — Chart-saver strap is clipped on after previous batch annealing record is torn off for lab.





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Silver Bay Plant will Pelletize Taconite Concentrates

. . . . an order for the design, engineering and materials for a new plant, has been placed by the Reserve Mining Co. for its new E. W. Davis Works at Silver Bay, Minn. . . . . it is estimated that this plant will cost around $19,000,000 and when in full operation, will turn out 12,000 tons of pellets each day . . . .

▲ THE successful development and marketing of a new process for the heat hardening of pellets made from taconite iron ore concentrates was announced recently by Arthur G. McKee & Co., steel-plant engineering and construction firm of Cleveland, and Allis-Chalmers Manufacturing Co. of Milwaukee.

An order for the design, engineering and materials for a new plant, incorporating the process, has been received by the McKee company from the Reserve Mining Co. for its new E. W. Davis Works at Silver Bay, Minn. It is estimated that this plant will cost around $19,000,000 and when in full operation, will turn out 12,000 tons of pellets each day.

Major advantages of the new metallurgical process for converting powdered taconite concentrate into an iron ore suitable for use in a blast furnace include: Its extreme simplicity of operation; the utilization of heat recovered from the operation; ease of quality-control resulting from the ability of the operator to see what is going on during the process; the direct and simple discharge of the product from the equipment; and the minimizing of breakage of the pellets because of their stationary position on the grate which carries them through the furnace.

The present high grade Mesabi ore, mined by the open pit method, as it comes out of the ground, contains approximately 50 per cent iron and 50 per cent impurities, which are removed. Taconite, on the other hand, contains only 20 to 30 per cent iron (in the form of oxides) mixed with 70 to 80 per cent impurities (in the form of iron carbonates, iron silicates, and quartz). The iron oxides are attracting industry's interest. To avoid vast expense in shipping unusable waste and make taconite economically acceptable at the steel mills, it must be processed before loading aboard ship. The average taconite, after concentration, will contain 60-65 per cent iron as compared to present "rich" ores at 50-52 per cent.

Iron ore, or the iron oxides are found in nature in two forms commonly referred to as magnetite and hematite. The former, as its name implies, is magnetic while hematite is not. Taconite having magnetite as its iron mineral requires an entirely different process of concentration than taconite with hematite, because the magnetic property of magnetite is the basis for separating it from the unusable waste or tailings.

Taconite is one of the harder and more abrasive rocks in the world and is the forerunner of the famous rich ore of the Mesabi Range open pit iron mines. On the Mesabi, taconite exists in layers of rock just below the earth's surface. The overburden is removed with the same equipment used in mining the taconite. After the overburden is removed, the taconite is prepared for blasting. This operation is being performed more and more by the newly developed jet piercing machines.

Figure 1 — This large gyratory crusher will be capable of crushing over 3500 tons of taconite per hour, from pieces as large as five feet on one dimension down to 10 inches in size.

After blasting, power shovels move the pile of loose rock. Taconite in its solid form in the earth weighs 220 lb per cu ft. In its loose form after blasting the air pockets between pieces reduce the unit weight to 133 lb per cu ft. Huge trucks, capable of carrying from 30 to 50 tons of rock, move in with the shovel and move the rock to the primary crusher.

The primary crusher is usually erected in a pit so that the top of the crusher is slightly below the road level. The trucks back up to the opening and dump their load directly into the open top of the crusher. The world's largest gyratory crusher, (Figure 1) now being manufactured by Allis-Chalmers Manufacturing Co., is scheduled to go into operation crushing taconite in 1955. It will have a receiving opening, which is the distance from the center of the crusher to the inner surface of the outer shell, of five ft and will utilize a 109-in. maximum diameter crushing cone.

The crushing cone is mounted in the center of the crusher shell. It is shaped much like a pharmacist's pestle with the wide section at the bottom of the shell. Two 500-hp motors will drive the cone in an eccentric motion, which will alternately increase and decrease the space between the tapered surface of the cone and the comparatively straight surface of the shell. When the space increases, any rock present at that time will slip down into the larger space. On the next cycle when the cone moves in to decrease the gap, it finds the rock in its way, and the machine crushes the rock and continues its eccentric path in the shell.

ing only in size. The rock, when it drops out of the secondary crusher, is reduced to less than 4-in. pieces. Total time required to reduce a rock as large as one cubic yard down to less than 4 in. may be less than one minute, and many huge rocks may be going through the primary and secondary crushers at the same time.

Two more stages of crushing follow, see Figure 2, with the rock emerging no larger than ¾ in. The third crusher is known as the tertiary crusher and the fourth is known as the quadarary crusher. Both of these crushers are usually of the gyratory type, but much smaller than either the primary or secondary.

erally used — rod mills and ball mills. Both contain much the same construction, being cylindrical in shape with the longitudinal axis horizontal, and a feed opening on one end and a discharge on the other. They both must revolve to do any grinding.

The mills differ mainly in the material used inside to do the grinding, which is called the grinding media. Rod mills use rods which may have a diameter as thick as four in. and in length extend from end to end. Size of the cylindrical shell may be from 10 to 12 ft in diameter and from 12 to 16 ft in length, and are usually filled about half full with rods. Total weight of the rod charge may go as high as

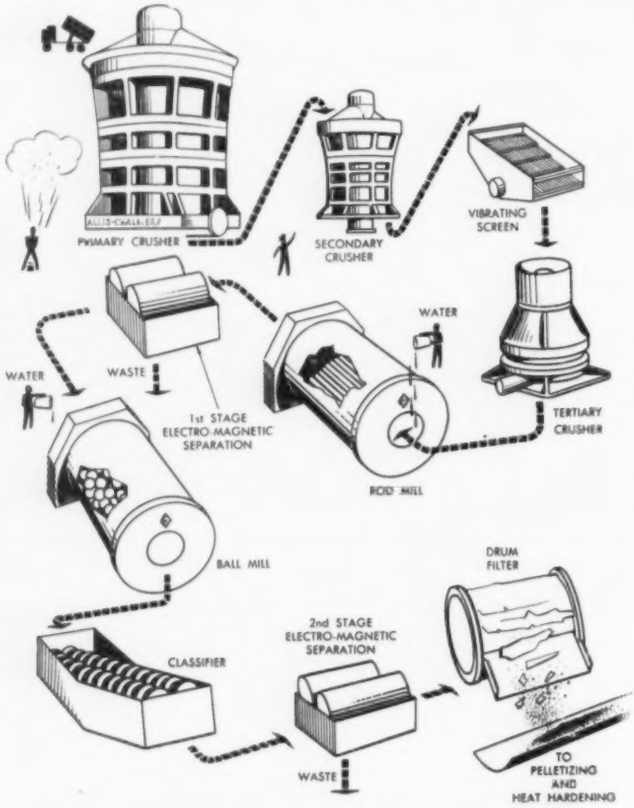

Figure 2 — Pictorial flow sheet shows how taconite is concentrated from 30-35 per cent iron to 60-65 per cent by the magnetic separation method. From the drum filter in the lower right, the iron concentrate goes to the pelletizing and the heat hardening process.

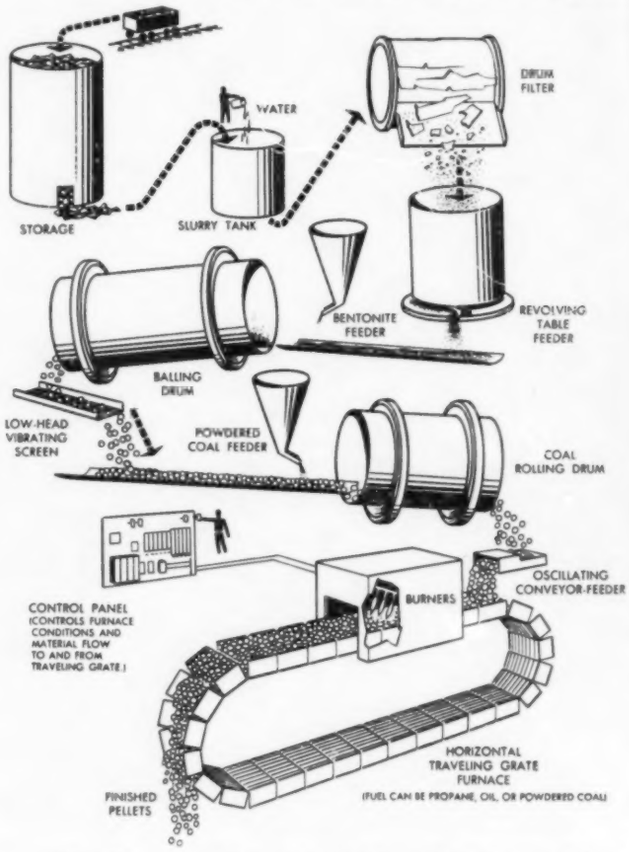

Figure 3 (right) — Pictorial flow sheet of the Allis-Chalmers Mfg. Co.-Arthur G. McKee Co. pilot plant at Carrollville, Wisc. Results obtained in pelletizing and heat hardening at this pilot plant led to the full scale commercial horizontal traveling grate now in operation on the Mesabi Range. Seven more full size units are scheduled for the E. W. Davis plant at Silver Bay, Minn., having an approximate cost of $19,000,000.

Pieces of hard taconite rock as large as five feet in one dimension will be crushed that way. The crusher will weigh 1,250,000 lb and will crush 3500 tons of rock every hour. Somewhat smaller units are carrying on the job at the present time.

The crushed rock drops out of the bottom of the primary crusher into the open cavity of the secondary crusher. This crusher duplicates the action of the primary crusher, differ-

Because the iron is present in the form of very small particles, the ¾-in. size rock must be further reduced in size — down to where it would be possible to shake it out of an ordinary pepper shaker. To accomplish this, grinding mills, rather than crushers, are used.

Grinding mills are not as spectacular as huge gyratory crushers, but the job they do is equally as important. Two types of these mills are gen-

110 tons. Speed at which a rod mill operates is usually around 15 revolutions per minute and when taconite is passing through the power needed is upwards of 800 hp. Over 120 tons of taconite can be ground every hour.

Size of the taconite rock entering the rod mill is a nominal ¾-in., and that being discharged is from 8 to 14 mesh.

When the magnetic taconite is discharged from the rod mill it is finally

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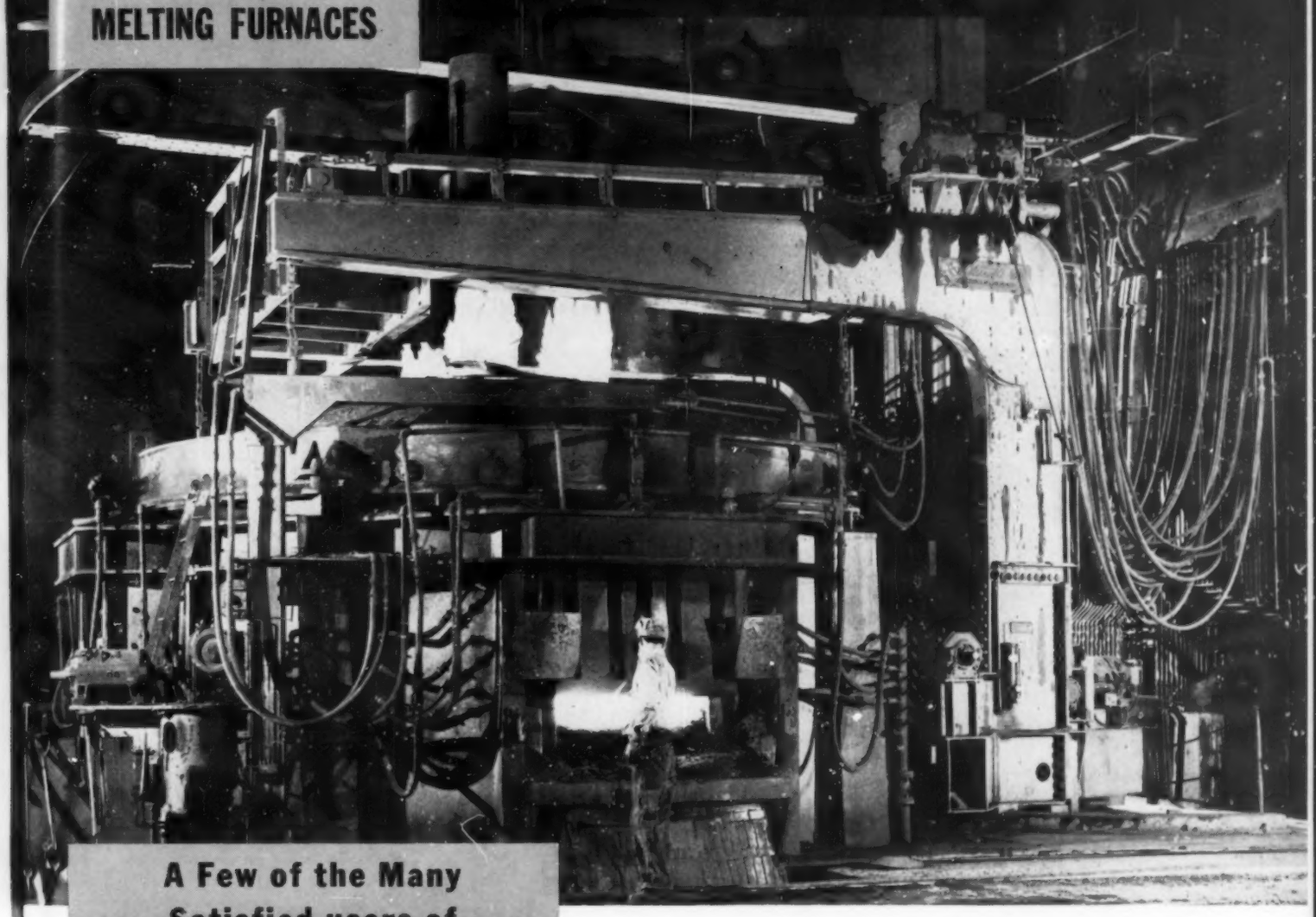

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small enough to go through the first stage of separation of iron from waste, or tailings, which is done with magnetic separators. The tailings at this point consist mostly of silica.

The magnetic taconite continues the process, going through the ball mill circuit next. This mill is similar in construction to the rod mill but is charged with steel balls instead of rods. The size of the ball mill may go as high as 10½ ft in diameter and 12 to 14 ft in length, with the grinding media filling approximately 40 per cent of the volume inside. In weight, it may amount to 70 tons of steel balls, each approximately two in. in diameter. Ball mills, like rod mills, rotate at approximately 15 rpm. The action that the balls go through to accomplish grinding follows the pattern set up by the rod mill.

Figure 4 — In the first step in the pelletizing and heat-hardening process, balls are being discharged from the balling drum, falling onto a vibrating screen where the undersized ones are being removed. These are returned to the feed end of the balling drum where they act as seed pellets in furthering the formation of balls. From the screen the balls are carried to the furnace on a traveling grate.

Particle size of the taconite being discharged from the ball mill may be as fine as 325 mesh. These fine particles then go through the final stage of separation, again by using magnetic separators. The tailings are removed in the same manner as they were after the rod mill. At this point, the iron minerals are concentrated to over 60 per cent iron. It is still water soaked, however, and the next operation is filtering, where practically all of the water is removed, leaving a black cake rich in iron.

At this point in the process, the problem of how to get this concentrated ore into the blast furnaces became one of primary importance. The strong up-drafts present in a blast furnace would carry the fine particles of taconite away from the furnace instead of into it.

Several methods of making the powdered iron acceptable to the blast furnaces were developed and are being tried on experimental pilot plants at the present time. Three of these methods are: nodulizing in a rotary kiln where the concentrated iron oxides are burned into nodules which are heavy enough to overcome the up-draft of the blast furnace; sintering, which burns a large continuous bed of iron oxide into one mass and then breaks it into chunks which are heavy enough to overcome the blast furnace up-draft; and finally pelletizing, where the iron ore concentrate is rolled into definite size balls heavy enough to overcome the up-draft and then burned to make them hard enough to resist breakage in transit to the furnaces.

Of the three methods mentioned above, the pelletizing method appears to be the most promising. It is in this phase of iron mining and steelmaking that the taconite pilot plant at Allis-Chalmers has pioneered.

The pilot plant at Carrollville, Wisc., has a capacity of approximately two to three tons per hour. A full-scale, commercial size plant went into operation at Babbitt, Minn., in February, 1954, producing 1000 tons per day. Further, commercial size plants are scheduled for Silver Bay, Minn., and will produce 12,000 tons of pellets per day when completed. Cost of the Silver Bay pelletizing and heat hardening installation will approximate $19,000,000.

The problem of bridging the gap from a small pilot plant to a full size commercial operation was successfully carried out due to the excellent results obtained in the pilot plant

Actually the entire development started out in a very small experimental pelletizing furnace in the laboratories of the Allis-Chalmers Research Division. From these experiments grew the pilot plant at Carrollville, (see Figure 3) and from this pilot plant grew the large scale commercial operation.

Concentrated taconite is shipped direct from the iron range to the pilot plant in railroad cars. A grab bucket mounted on a boom crane unloads the taconite, dropping it through a roof hatch in the pilot plant directly into a holding tank. The concentrates are manually removed from the bot-

Figure 5 — A handful of heat hardened pellets of taconite concentrate. The purpose of heat hardening the pellets is to make them tough enough to withstand shipment from iron range to blast furnace without breaking.

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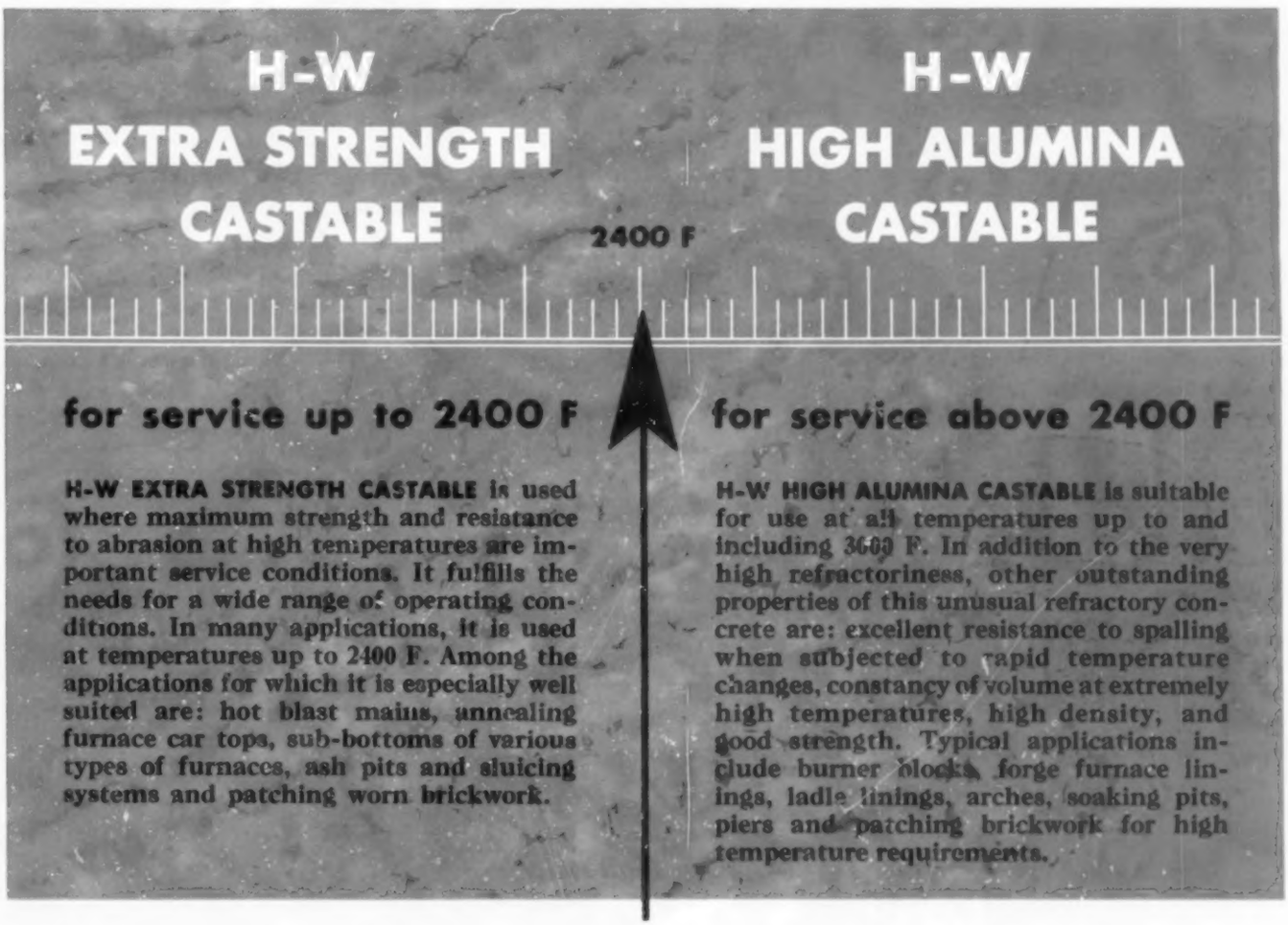
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WORLD'S LARGEST PRODUCER OF REFRACTORIES
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Sure, that old pump still works,

but how much does it cost to keep?

That rugged old pump of yours may not be the bargain that it seems. Let's do some arithmetic. If the efficiency of the old pump is 75% vs. the 85% efficiency of the new pump, you are paying more to keep it than you would to replace it. That's because a new unit of equivalent output uses less power. Thus it soon saves its own cost — then begins to pay dividends.

Let's take a specific example—a small general service pump

Old pump efficiency 70%	**28.9 BHP**
New pump efficiency 79%	**25.6 BHP**
	3.3 BHP Saving

On the basis of 1¢ per KWH, the 3.3 BHP saving for a 6000-hour year (approximately 16 hours per day) amounts to $150. This saving, capitalized in 4 years at 4% adds up to $630. Yet the price of the new pump that saves $630 is only $438.

What would the pump replacement profit be in your particular case? Your De Laval representative can tell you exactly — in dollars and cents — as soon as he has the basic facts on your present installation. Call him in today or write to De Laval for Pump Fax Bulletin which includes a valuable "power-savings" chart.

DE LAVAL *Pumps*

DE LAVAL STEAM TURBINE COMPANY
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DL237A

tom of the holding tank across a scraper apron and loaded onto a belt conveyor which feeds the repulping tank.

In the repulping tank a metered amount of make-up water is added to form a slurry. Repulping of the slurry is done by two impeller agitators in the tank. The resultant slurry is then pumped by a rubber lined solids handling pump to a drum filter which is equipped with an overflow to return any excess slurry back to the repulping tank.

The drum filter removes excess moisture from the concentrate, leaving approximately ten per cent in the feed to the pelletizing operation.

The filter cake then drops onto a belt conveyor which takes it up to a table feeder. Concentrates from the table feeder pass onto a belt conveyor which goes to the pelletizing drum. A small vibrating feeder is mounted over this belt for the purpose of metering additives to the concentrate. The additive acts as a bonding agent to reduce the possibility of breakage when the concentrates are rolled into pellets, or balls.

The concentrates next go into the pelletizing or balling drum, which is an open drum set at a slight angle and continuously revolving. Concentrates enter at the higher end and pellets are discharged at the lower end. Acceptable pellets are approximately ½ in. in diameter, varying from ⅜ to ⅝ in. They contain about 10 per cent moisture.

Provision is made to remove those pellets which did not meet size requirements. This is done by means of a vibrating screen located under the discharge end of the balling drum. All pellets are discharged onto this screen. The undersize fall through onto a conveyor belt which returns them to the belt feeding the balling drum. Upon entering the drum for the second time these pellets act as seed pellets and literally keep the balling process going in the balling drum.

Correct size pellets pass across the vibrating screen and fall onto a conveyor which passes under a metering coal-feed device and feeds the coal reroll drum. Powdered anthracite coal is added to the pellets on the conveyor. In the coal reroll drum the pellets go through the same type of action as in the balling drum, but the purpose differs. Here the powdered coal is rolled into the surface of the pellets.

The pellets are next conveyed onto the 6 ft wide traveling grate of the heat-hardening furnace, a unit about 200 ft long. A belt conveyor which oscillates much like an ordinary house fan, deposits an even layer of pellets across the full width at a rate of about 50 to 55 tons per hr.

The grate is a continuous operating machine, generally known as the sintering type. This particular one has certain furnace and wind-box modifications built into it.

The pellets, as they are deposited on the grate, are called "green" pellets, a classification determined by the fact that the pellets have not passed through the furnace.

In the process of forming the pellets a certain amount of moisture is necessary to cause the concentrates to become pellets. Now, however, moisture is undesirable because the purpose of the furnace is to harden the pellets by heat. Therefore, the first phase is pre-drying, which is accomplished by an up-draft of hot gases passing through the entire bed of pellets. These hot gases come from the discharge end of the grate where the pellets that are already burned are cooled by air passing down through the pellet bed.

From the pre-drying phase the grate passes under a three-compartment furnace. The first compartment is used for down-draft drying and utilizes hot gases from the recuperation wind-box for this purpose. The second compartment is used for preheating the pellets, and additional heat from a burner located in this compartment supplements the temperature.

The last compartment is the ignition chamber and incorporates a burner for increasing the temperature to 2300-2400 F, which ignites the top layer of pellets. This burning zone progresses uniformly down through the 1 -in. deep pellet bed, at a burning rate of about one in. per minute, with burn-through taking place as the pellets reach the recuperation wind-box. A molecular change in the concentrate also gives off heat amounting to about 40 per cent of that needed. The ignition wind-box gases are exhausted to atmosphere. Grate moves forward at a rate of about 30 in. per minute and burning takes place in about a 30-ft section of the machine.

After passing over the recuperation wind-box, the pellets pass over the cooling wind-box and are then discharged through a grizzly deck onto a wire belt conveyor. They are then conveyed to the outside of the building where the finished pellets are screened and stockpiled.

WANTED!

There is a constant demand for copies of "The Modern Strip Mill," published by the Association of Iron and Steel Engineers. If your copy is not in use please get in touch with us.

ASSOCIATION OF IRON AND STEEL ENGINEERS, 1010 EMPIRE BLDG., PITTSBURGH 22, PA.

More Features of EC&M TYPE SW ALL-WELDED LIFTING MAGNETS Assure More Dollar Value

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EC&M Type SW ALL-WELDED Lifting Magnets have a new look . . . inside as well as outside. Stronger, better designed to withstand the hard knocks encountered in magnet operation, they are easier to maneuver, and through high lifting capacity they reduce handling costs.

The magnet-coil is wound between turn with purer, thinner asbestos tape, with its strength increased by impregnation with EC&M No. 281 compound. Between layers, the insulation is a new product—ECAMICA board which is moisture-free, has high dielectric strength and excellent mechanical ability. A new fabricating process locks the windings against movement.

Look at the features pictured here in the top and bottom views of the magnet. Remember, too, that these EC&M magnets are ALL-WELDED to keep pole shoes tight—to keep moisture out—to increase the efficiency of the magnetic circuit and to prolong magnet life.

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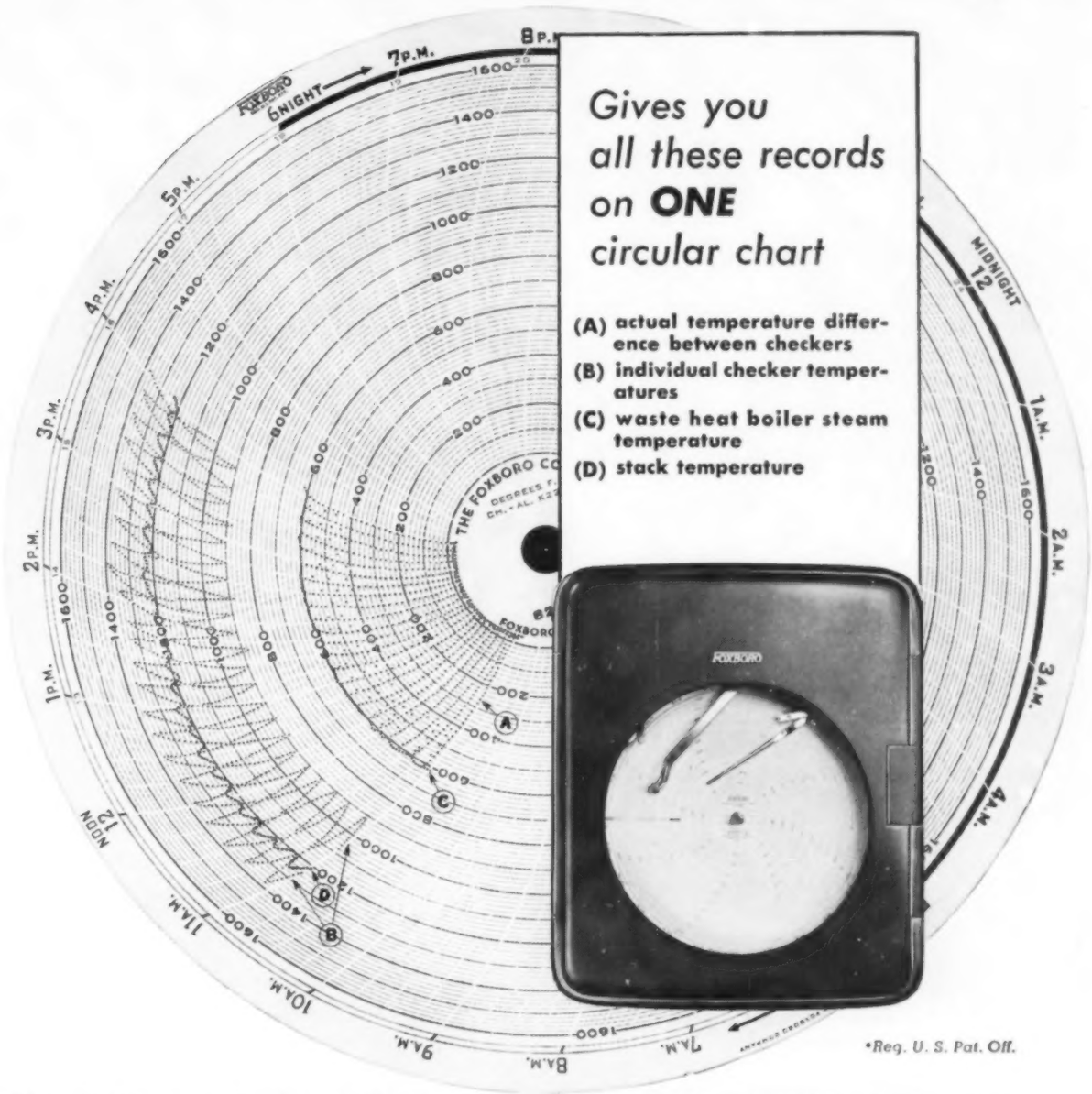
THE ELECTRIC CONTROLLER & MFG. CO.

2698 EAST 79TH STREET ★ CLEVELAND 4, OHIO

Only DYNALOG* electronic OPEN HEARTH REVERSAL . . .



*Reg. U. S. Pat. Off.

This versatile open hearth reversal controller not only keeps the bath at peak temperature without damage to checker brickwork, but also records key temperatures in the regenerative and waste heat systems at the same time.

Because all these records are accumulated on one circular chart, in distinctive coded colors, open hearth operation becomes easier, more efficient. There's a real saving in panel space, too.

Reversal control is actuated by checker temperature difference, or high checker temperature . . . whichever pre-set limit occurs first. Can be interwired with time reversal systems. Warning alarms and direction-of-firing signals are available options.

For complete information, write for your copy of Engineering Data Sheet 330-12 or consult your local Foxboro Field Engineer.

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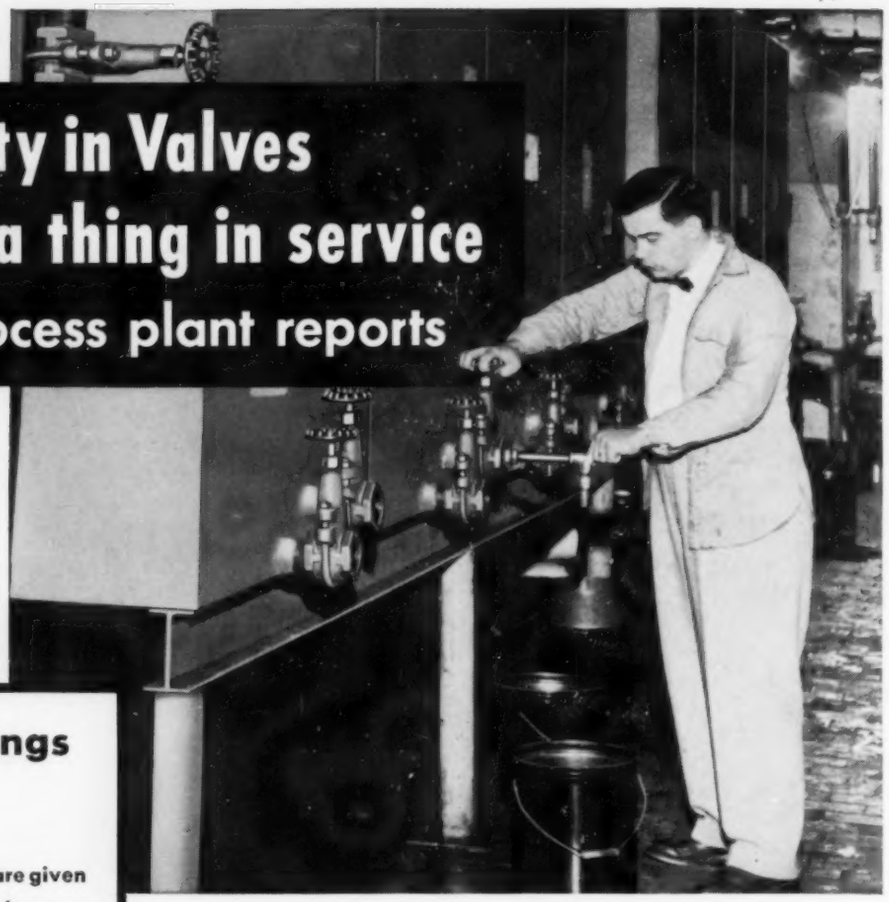
FOXBORO REG. U. S. PAT. OFF. — DYNALOG TEMPERATURE CONTROL

FACTORIES IN THE UNITED STATES, CANADA, AND ENGLAND

Similarity in Valves doesn't mean a thing in service

...Chicago process plant reports



The Installation

At Hysan Products Co., Chicago manufacturer of liquid waxes, pine oil and coal tar disinfectants, liquid soaps, insecticides and various chemical specialties—where Crane clamp gate valves have been installed on all process and storage piping.

Valve Service Ratings

SUITABILITY: Performance-proved
FEATURES: Tight seating
MAINTENANCE COST: Only routine care given
SERVICE LIFE: Many times former valves—still like new
OPERATING RESULTS: Costly loss and trouble stopped
AVAILABILITY: Crane Catalog item—No. 488

The Valve

Crane clamp gates are of rugged design, with seating surfaces machined to close tolerances. That's why they provide long-lasting, tight closure, even where operation is frequent and fluids are hard to hold. Many patterns to choose from in these compact valves—all iron or brass-trimmed. Consult your Crane Catalog or your Crane Representative.

The Case History

Longest service given by similar type valves formerly used was from 2 to 6 months. They failed to hold tight at seats and disc under daily operation of 3 to 12 cycles. Valve maintenance and replacements were excessively costly—as were down-time losses. Leaky valves on tank lines forced repeated transfer of storage stock. Up to 3 men were needed to make valve repairs.

Only when the plant switched to Crane No. 488 clamp gate valves was the trouble stopped. Installed more than a year ago, the valves show no sign of wear or leakage. Only an occasional pull-up on the packing nut is needed—and only one man for all piping maintenance.

What's the answer? Better quality valves, obviously—the only way to assure better service and lower ultimate cost.

THE BETTER QUALITY . . . BIGGER VALUE LINE . . . IN BRASS, IRON, STEEL

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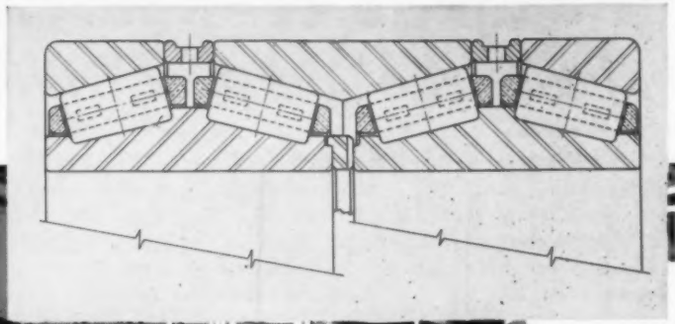
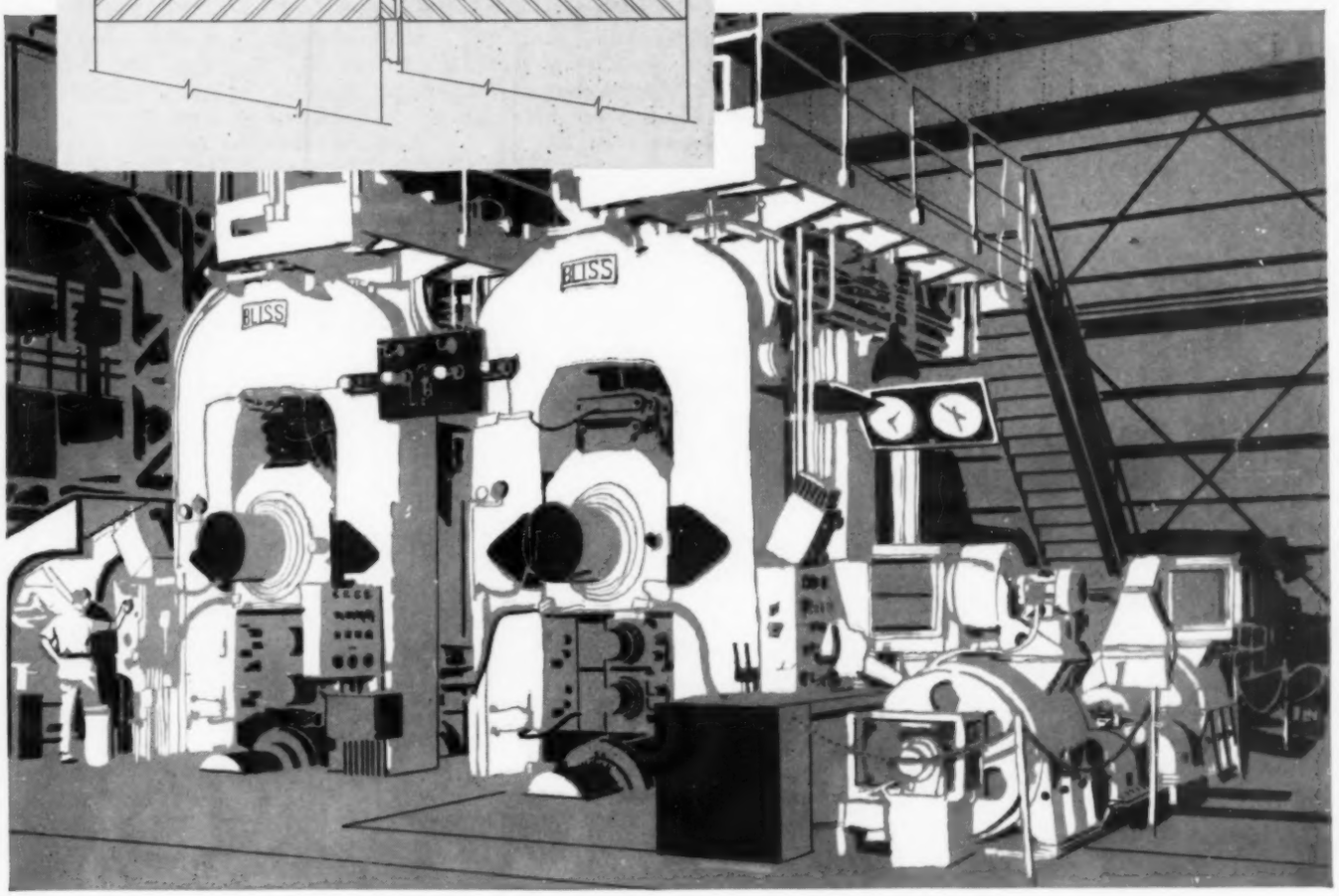
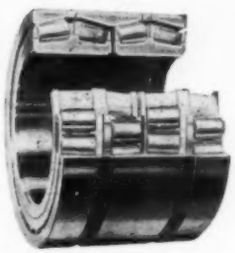
TORRINGTON BEARINGS AT WORK



This Bliss Tin Temper Mill at the Fairless Works of United States Steel Corporation uses TORRINGTON Work Roll Bearings and 2-Row Tapered Roller Bearings for thrust, mounted with oil film bearings on back-up rolls. A 2-High Sheet Temper Mill is also equipped with TORRINGTON Roll Neck Bearings.



High capacity long service!



TORRINGTON Work Roll Bearings are designed and built for tough, grueling service. That's why only the highest quality, electric furnace, alloy steel is used, carefully carburized and heat treated for hardness... stability... uniformity. To achieve high thrust capacity, TORRINGTON Work Roll Bearings are designed with steep angle construction. This means better service under actual operating conditions. One-piece, cast-bronze cages, with machined pads in each roller pocket reduce wear, make longer, low maintenance possible.

Specify TORRINGTON Work Roll Bearings and get these advantages in your steel mill equipment. Our engineering department will be happy to lend a hand on any design problem and help select the correct TORRINGTON bearing for your application.

THE TORRINGTON COMPANY
South Bend 21, Ind. Torrington, Conn.

District offices and distributors in principal cities of United States and Canada

TORRINGTON BEARINGS

Spherical Roller • Tapered Roller • Cylindrical Roller • Needle • Ball • Needle Rollers

Unloads 300 tons of bauxite per hour...

TIMKEN® bearings take the loads with minimum friction

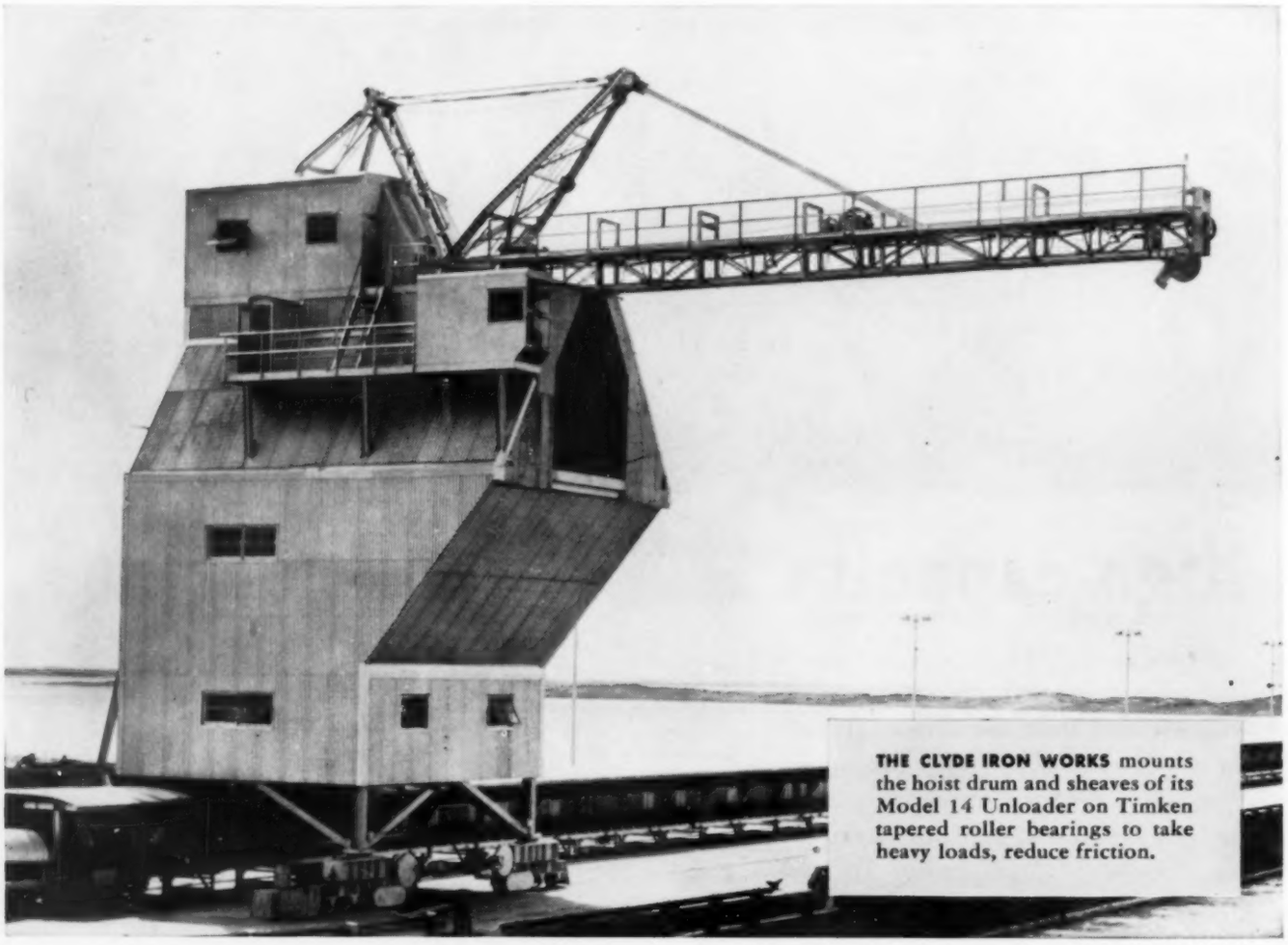
THIS traveling Clyde Unloader transfers bauxite ore from ship to conveyor at the rate of 300 tons per hour. To take the terrific loads imposed on the hoist drum and sheaves, and to keep them operating with less friction, Clyde mounts them on Timken® tapered roller bearings.

The Timken bearings have extra load-carrying capacity due to full line contact between the rollers and races. The tapered construction of the bearings lets them take radial and thrust loads in any combination. And power loss is reduced because the true rolling motion and incredibly smooth surface finish of Timken bearings practically eliminate friction.

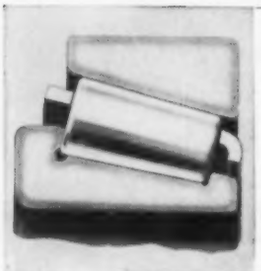
Timken bearings are made of the highest quality steel yet developed for bearings—Timken fine alloy steel. To get steel good enough for Timken bearings, we have to make our own. No other U. S. bearing manufacturer does it.

No other bearing offers you all the advantages you get with Timken tapered roller bearings. Be sure you specify them for all the equipment you build or buy. Look for the "Timken" trade-mark on every bearing. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.



THE CLYDE IRON WORKS mounts the hoist drum and sheaves of its Model 14 Unloader on Timken tapered roller bearings to take heavy loads, reduce friction.



GREATER LOAD AREA

Because the load is carried on the *line* of contact between rollers and races, Timken bearings carry greater loads, hold shafts in line, wear longer.

The Timken Roller Bearing Company is the acknowledged leader in: 1. advanced design; 2. precision manufacturing; 3. rigid quality control; 4. special analysis Timken steels.

TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

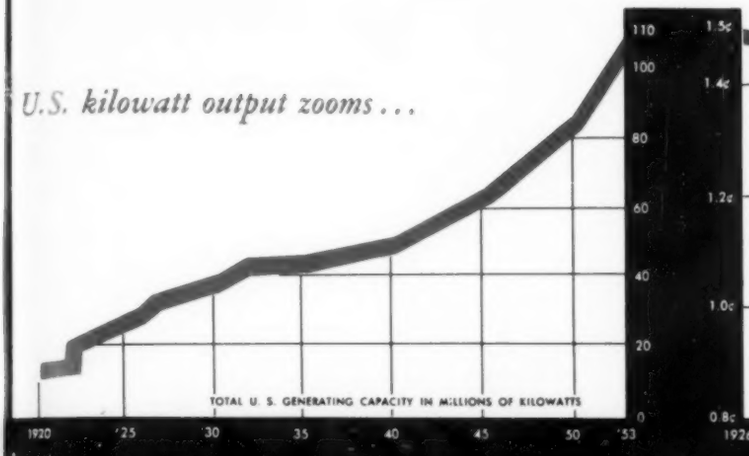
TAPERED ROLLER BEARINGS

NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL ◫ AND THRUST →◫← LOADS OR ANY COMBINATION ✳

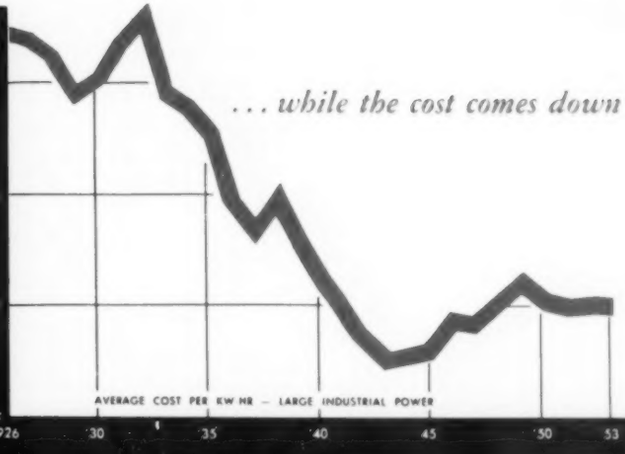
NATIONAL CARBON COMPANY'S

CARBON AND GRAPHITE NEWS

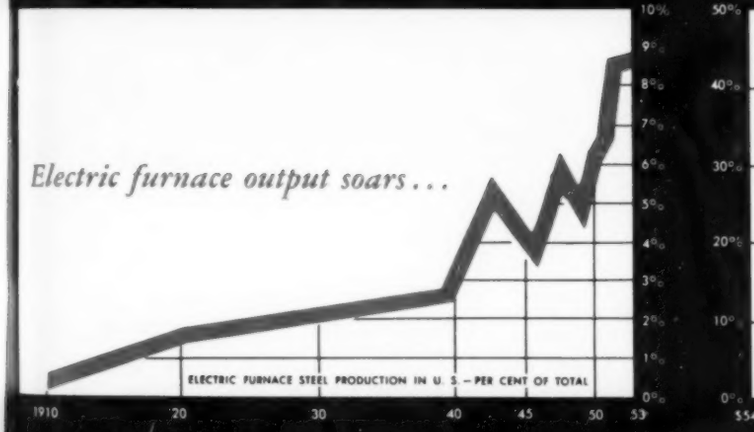
U.S. kilowatt output zooms . . .



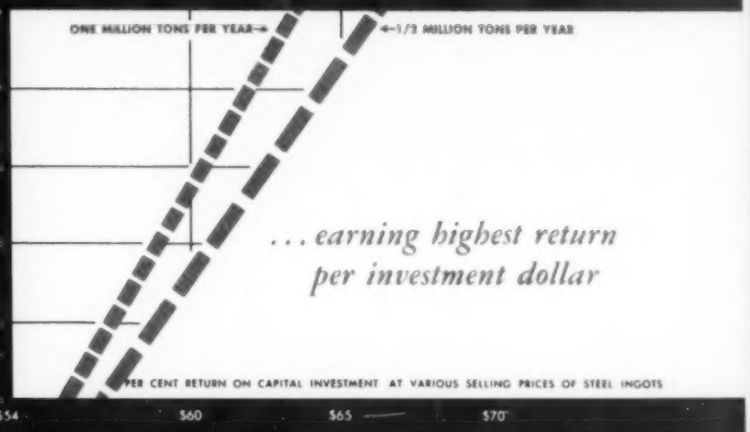
. . . while the cost comes down



Electric furnace output soars . . .

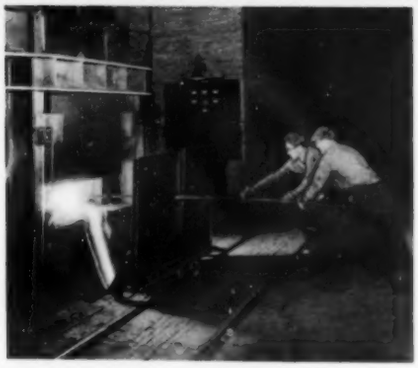


. . . earning highest return per investment dollar

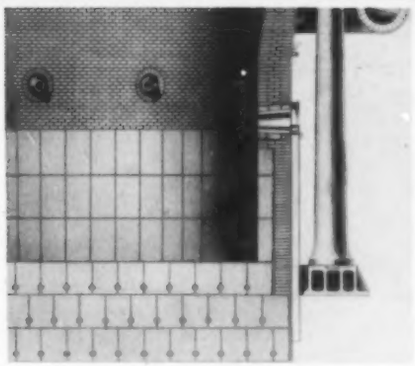


IN THIS ISSUE

Guest author Charles W. Vokac brings broad experience to his subject: THE ELECTRIC ARC FURNACE—AN APPRAISAL FOR MANAGEMENT.



Graphite slag-door sills cut costs, improve handling of high temperature slags in electric furnace production of stainless steels.



New design of carbon blast furnace linings features thicker, "locked-in" hearth-beams, accurately machined mating surfaces.

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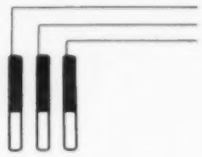
CARBON AND GRAPHITE NEWS
DECEMBER, 1954—Vol. 1, No. 2



THE MANY letters received praising the article by guest author W. B. Wallis in the first issue of CARBON AND GRAPHITE NEWS confirm our decision to make these pages, in part at least, a forum for industry's leading spokesmen.

The interests and problems of Management, whether executive, administrative or operating, are very similar and, of necessity, parallel. With concern for economy and efficiency at an all-time high, C. W. Vokac's article in this issue, THE ELECTRIC ARC FURNACE—AN APPRAISAL FOR MANAGEMENT, would seem to be especially timely for the steel industry. Mr. Vokac has deliberately avoided a detailed discussion of any one phase of electric furnace operation in order to bring you a broad, general picture of its role in modern steel manufacture.

Future issues of CARBON AND GRAPHITE NEWS will deal in more specific terms with various aspects of the electric arc furnace, and spokesmen on these subjects will be among the most highly qualified men available within the industry.

You may be sure that no effort will be spared to sustain this publication at a high level of industrial service, and we hope you will continue to make your suggestions known to us at every opportunity.

A. F. Johnson

PRESIDENT

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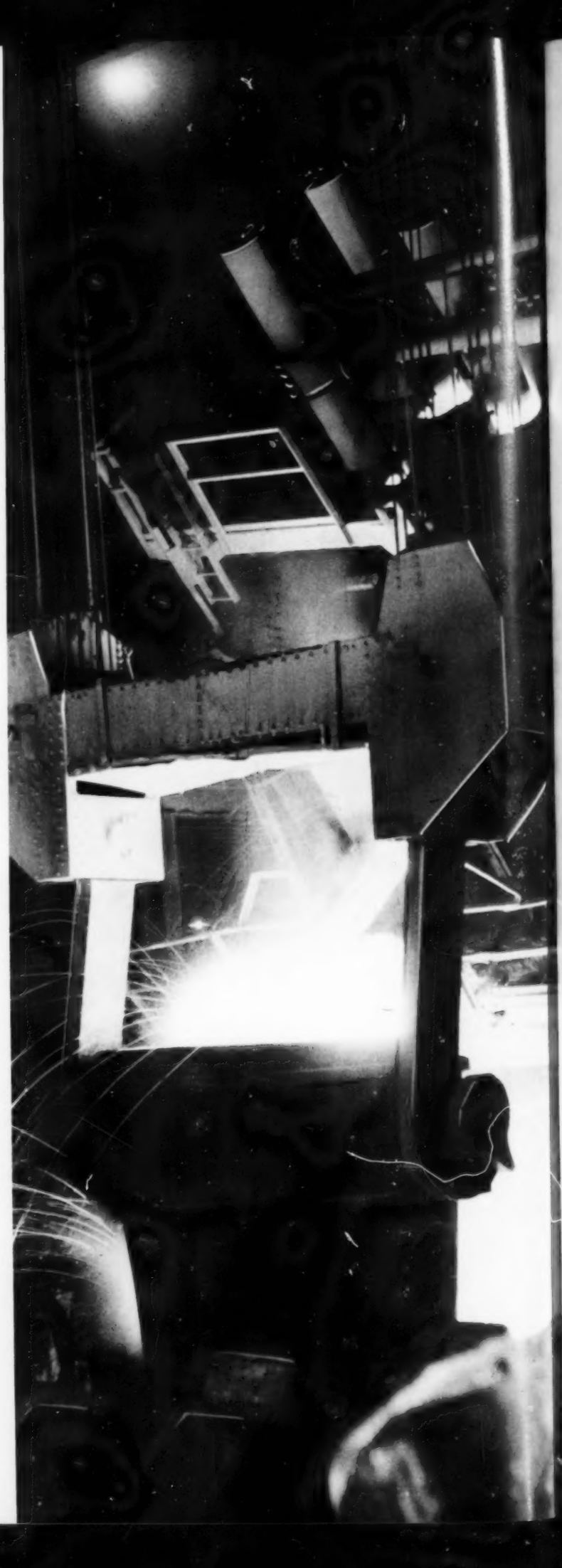
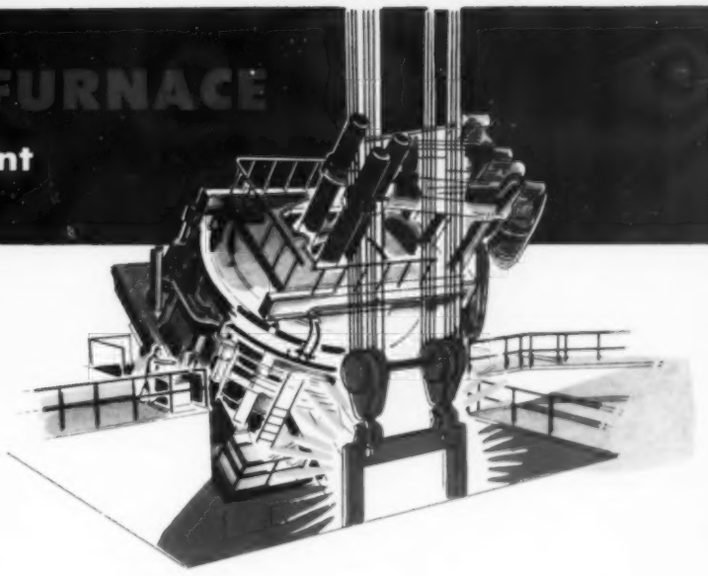


THE ELECTRIC ARC FURNACE

...an appraisal for Management



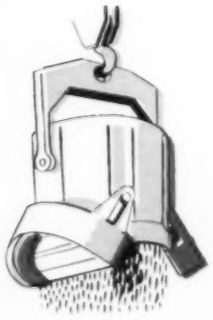
By Charles W. Vokac

With the Steel Industry's backlog a thing of the past and the search for new markets and more efficient methods intensified, operating management should be more than ever aware of the electric arc furnace as its most flexible and dynamic production tool.

It's the expanding nature of the electric furnace—its rapid growth in size, design and application—which requires constant re-appraisal by and for management, both operating and administrative.

It is not the purpose of this discussion to add to an already voluminous library of electric furnace technical data, but rather to evaluate its known characteristics and capabilities in the light of *current* management problems such as: a reduced work-week, fluctuating markets, high fuel and materials costs and increasingly competitive interest among steel producers in a product of high, uniform quality at lowest cost.

After the following brief review of major applications, an analysis is made of some specific ways in which modern arc furnaces meet steel management's toughest problems. Among the topics considered will be: "on-and-off" economy; the relation of temperature control to the critical consideration of product quality; heat efficiency vs. fuel cost; increased capacity and its relation to production expense; a summary of electric furnace features as they affect distribution of fixed charges, maintenance and pay-out of equipment, and overall plant efficiency. All these factors are parts of the delivered-price equation which determines who gets what portion of how much business.



Variety of Uses

In the iron foundry, the arc furnace is a familiar piece of equipment. It is quite widely used as a complement to the cupola to duplex cupola iron. By this practice, the increasing demand for closer metallurgical control of the iron and of its temperature is being met despite the continually decreasing quality of materials available for cupola charging. The addition of the electric furnace to this operation not only has improved the quality of the iron being cast but has reduced its cost as well. Where economic conditions are favorable, and the tonnage is low enough, arc furnaces alone do the entire job – melting, heating and refining at less cost per ton.

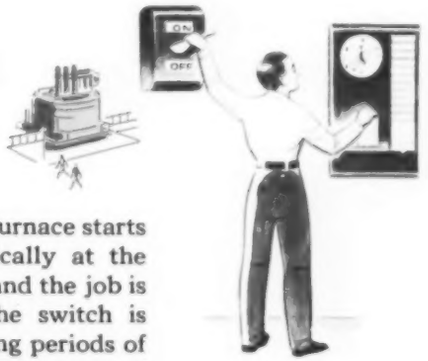
In the steel foundry, the electric furnace has been doing these jobs for over a generation. It produces all types of steel castings. Comparatively few steel castings are now made with other than electric furnace steel.

The arc furnace has been producing tool steels and other alloy steel ingots for a long time. Over the past several years it also has made a considerable proportion of the ordinary carbon steel ingot tonnage in steel plants and the proportion is becoming greater every year.

In calcium carbide and ferro-alloy plants the electric arc furnace is extensively used for production of carbides, ferrosilicon, ferrochrome, phosphorus, silicon and many other allied products. Today, electric arc furnaces do many other smelting and melting operations which cannot be done practically or efficiently with any other type of equipment.

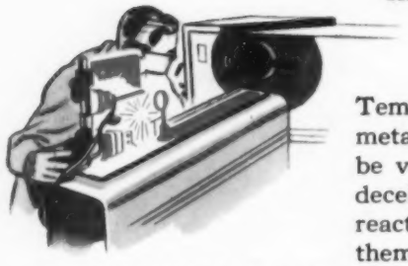
New applications of the electric arc furnace are being continually developed and expanded; its possibilities seem almost limitless. Processes which for generations have been carried on in gas, oil or coal-fired furnaces now are performed in electrics. Increasing demands for new metals, new alloys, new materials, and for improved qualities of the older ones are being met by the arc furnace.

On-and-Off Economy



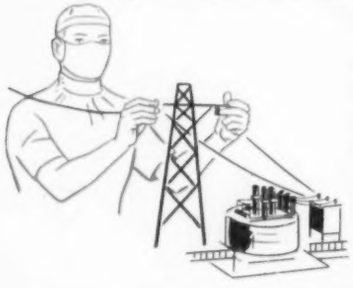
The electric arc furnace starts producing practically at the turn of a switch and the job is finished when the switch is turned again. Long periods of preparation, preheating and soaking are eliminated. Neither is there lengthy preparation for shut-down. Arc furnaces can be economically fitted to the more desirable, single-shift, 5-day-week schedule of operation.

Closer Metallurgical Control Improves Product



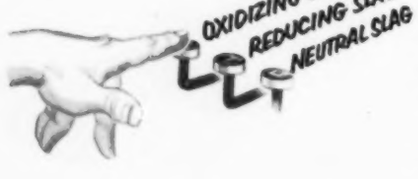
Temperature is a useful metallurgical tool and can be varied to accelerate or decelerate certain chemical reactions and even reverse them. In the refining process, it is highly desirable for one to be able to vary the temperature of the charge at will and to have complete control of it. In the electric arc furnace the temperature of the charge can be regulated to a high degree of accuracy.

Metallurgical control in all furnace processes is paramount. Control over what goes into the furnace is of equal importance in order to control the quality of the product from the furnace. Particular effort must be exercised to prevent any deleterious elements from entering the furnace. Gas, oil, coal and coal derivatives when fired in metallurgical furnaces, carry undesirable elements into them. These elements contaminate the charge and often uncontrollably change its character. Electric energy, on the other hand, is a perfect metallurgical fuel – *there is no other fuel like it.* The power companies are able to burn the lowest grades of coal, gas or oil (the better grades are rapidly becoming exhausted) to generate this "perfect fuel". All the contaminating elements and gases thus have been completely "filtered" out *before* this fuel reaches the electric furnace.



The materials available for charging the furnace seldom are of the same chemical analysis as that required in the product. In the electric arc furnace, the charge, after it is melted, may be worked under an oxidizing, a reducing, or a neutral slag. This *chemical* control, and the *temperature* control already mentioned, permit a wide selection of lower-cost charging materials and result in extremely efficient metallurgical control of the product.

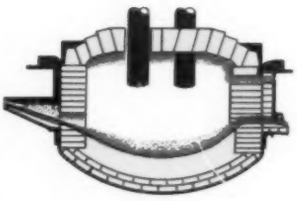
By such close control, desirable alloys in the charge may be retained with a high degree of recovery; alloys required in the product and not present in the charge can be added, also with a high degree of recovery; and alloys in the charge but undesirable in the finished product can be reduced to practically any desired limit.



Operating Costs Down

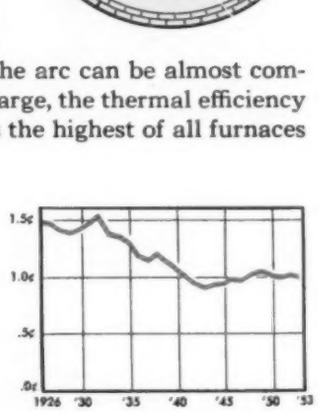
- Operating costs are reduced because the furnace can be turned on or off conveniently with no delays. The furnace is producing as soon as it is turned on and keeps producing until it is turned off.
- Operating costs are reduced because the furnace can be operated during regular working hours of the day and regular working days of the week. The efficiency of the personnel is also improved.
- Operating costs are reduced and the quality of the product is improved because the operator has complete control over the temperature of the burden within the furnace.
- The cost of the product is reduced because lower-cost materials can be used in the charge.

High Heat Efficiency



Since electricity is of a high order it can be completely converted into heat. Since the arc can be almost completely enveloped by the charge, the thermal efficiency of the electric arc furnace is the highest of all furnaces by a large margin.

Low-Cost "Fuel"



The cost of electrical energy is becoming more and more favorable as compared with other fuels. The unprecedented growth of the power generating industry and more stable and higher capacity power distribution networks make it possible now to feed the arc furnace with all the energy it can take and as fast as it can take it. The result is a furnace which is faster, more productive and more economical, further improving its competitive position and its broadening use for more and new processes.

Improved Designs Increase Capacity, Reduce Costs

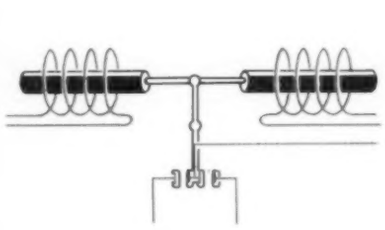
Improvements in the design of the electric arc furnace are keeping pace with other developments and demands

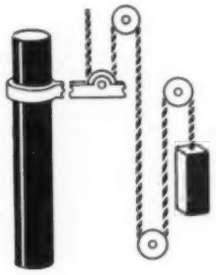
Product Quality Up

- Cost of the product is reduced because lower cost alloys can be used, less alloying is needed and a high ratio of alloy recovery is attained.
- Quality of the product is improved because the operator has complete control over everything that goes into the furnace including the "fuel" which has been "filtered" in the power-generating plant.
- Costs go down and production goes up because the availability of useful equipment is increased. Side-charged furnaces require approximately an hour for the charging operation; the top-charged furnace can be charged in a few minutes. Slipping electrodes in old screw-and-wedge type clamps required several minutes; with automatic electrode clamps, it can be done in seconds, and by one man instead of two.

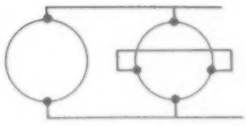
of the industry. The electric arc furnace has been made steadily more productive by the addition of the top-charging feature, the automatic electrode clamp, improved electrodes and refractories, and general simplification and dependability of all components comprising the complete installation.

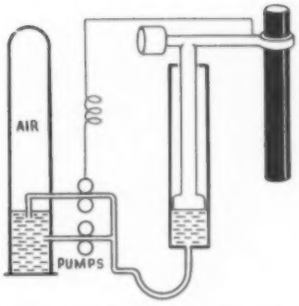
Greater and more efficient utilization of the power delivered to the furnace is made possible by the improved furnace controls used today. Automation began with a contact-making ammeter to operate the reversing contactors controlling the reversing electrode motor which, through a dead-ended cable drive, positioned the electrode and controlled the arc current. Later, a balanced-beam type of relay operated the reversing contactors and a balanced-cable drive positioned the electrode to control the arc current and voltage. Still



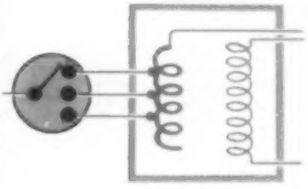


later, a differential field rotary generator operated the reversing electrode motor and an air-counterbalanced hydraulic electrode drive was used to control the arc voltage and current by responding to the degree to which the arc was off-balance. And now, a new control is available which essentially is a hydraulic differential energized directly from the furnace bus to control the product of the arc voltage and current that produces the heat generated within the furnace.



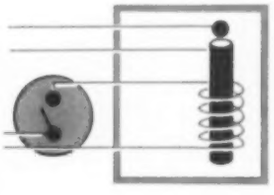


Automation also was applied to other components of the electric arc furnace, increasing its adaptability to additional processes. Tap changers on the furnace transformer were motorized so that the operator could make voltage-tap selections as the operation required, simply by turning a tap changer switch on his panel board.



Consideration is being given to general use of so-called "on-load" tap changers so that the operator need not turn off the power to the furnace to make voltage-tap selections. This would increase further the productivity of the furnace. However, the economics of this change have yet to be proved; the "on-load" tap changer costs more to build; at present it apparently cannot be built to prevent at least some arcing during its use and this is conducive to increased maintenance. On the other hand, its use would reduce maintenance on the furnace switch or breaker which would not be operated as frequently with the "on-load" tap changer. It appears that the initial increase in cost may be the sole criterion in this case.

Higher voltage melt-down taps are now being used for faster melting. Higher voltage means more heat input with the same current and avoids the need for overloading electrodes and circuits to obtain optimum production from the furnace.



The furnace switch or circuit breaker went through an evolution of improvement also. It, too, is now automatically operated with a switch on the operator's panel, increasing still further the availability of the electric arc furnace.

Concurrently with evolution of furnace design, suppliers of such vital accessories as electrodes and nipples have constantly improved the quality and design of their products. Today, graphite has virtually replaced carbon in such manufacture and brings to the modern electric furnace its advantages of higher conductivity, resistance to oxidation and high mechanical strength. Development of the tapered nipple joint and the smaller nipple sizes has cut column make-up time, reduced cost and improved efficiency.

(Concluded on last page)

Interesting Developments in Carbon and Graphite Applications

Ferro-Manganese Cooling Beds

As an alloying agent in steel, ferro-manganese is a refining element because of its powerful attraction for oxygen and sulphur. It acts as a deoxidizer and cleanser of molten steel; it combines with the sulphur, thereby greatly improving the hot-working properties of the steel; and it acts as an alloying element to improve the strength, toughness and response to heat treatment of a wide variety of structural and engineering steels.

There is no doubt that the production of ferro-manganese has been plagued since its introduction into the steel age by the problems introduced by contamination and thermal difficulties that are common throughout the entire metals industry.

In the production of ferro-manganese, the hot metal, after melting and refining in the furnace, is poured into cooling beds or chill trays. Cooling beds have been of short life, are expensive to maintain, and contaminate the metal.

Many schemes have been tried to improve bed construction but none has met the requirements as well as carbon or graphite blocks to replace the cast iron slabs and bed dividers. One large manganese producer was having so much trouble with bed maintenance, short life, metal inclusions and other assorted difficulties that a decision was made in 1952 to try carbon lined beds.

At one of the company's mills there are eight beds placed in line, with a common feed header running the entire length, having suitable "gates" at each bed. The bottom of each bed now is lined with between 3,000 and 3,500 lb. of carbon. After placing the blocks in position the joints are filled and the surface coated with a clay and water slurry and recoated after each use. Carbon blocks also are used as bed separators, since the bed, essentially, is a single large one, divided into the eight separate compartments.

Between 35 and 40 tons of metal are cast into each bed at each tapping and a total of better than 8,000 tons can be cast before it is necessary to remove the blocks and make a new installation. This represents upwards of fourteen months of bed life in contrast to between nine and twelve months of service life from cast iron beds.

The result of carbon bed usage has been similar at both plants of the company. One notable difference, however, has occurred at one plant where two beds have been in service for over a year and show such a slow rate of wear they are expected to remain in operation for another year. Carbon lined beds have been so satisfactory that carbon or graphite will replace other materials as each bed is rebuilt.

The principal advantages of carbon lined beds that are emphasized by company officials are: lower cost (approximately one half as much per ton of metal as with former beds); the metal does not stick to the bed and, therefore, less time is required for its removal; the metal chills more quickly, due to the very high heat transfer rate of the bed material, thus improving the metal grain structure; and the metal is much cleaner.

The variety of sizes and shapes available in either carbon or graphite lend themselves to the design of large beds or small trays to handle both blast furnace and electric arc furnace production of ferro-manganese.

Graphite Slag-Door Sills

for electric furnace production of stainless steel

The making of stainless steel is a specialized phase of steel manufacture. The word "stainless" is synonomous with refinement, quality and silvery luster. Purity and quality must be there whether we visualize cooking pots, kitchen sinks, jet engine parts, steaming chemical cauldrons, structural shapes or beautiful ornamentation. It must be twisted, turned, welded, riveted, rolled, shaped and deep drawn, and it must be corrosion, rust and stain resistant, tough and strong. It is truly the aristocrat of steels.

The alloying elements in stainless steel require high furnace heats, while the cleansing agents are just as demanding. When dealing with a furnace charge that may be worth a small fortune, the ingredients must be blended carefully and closely controlled. The superheated, erosive, chemically reactive slag that collects the impurities from the seething metal is especially rough to handle. *Photo right*→

Copies of CARBON AND GRAPHITE NEWS, Vol. 1, No. 1, Featuring the article, "Electric Furnace Steel – Past, Present and Future", by W. B. Wallis, are still available.

Write National Carbon Company, 30 East 42nd Street, New York 17, New York, giving name, title and company address.

CARBON AND GRAPHITE WILL NOT STICK, SHRINK, MELT . . . . . .

The unique chemical and physical properties of carbon and graphite make them the most acceptable of all materials for metallurgical applications wherever "the metal runs hot". They are not wetted by molten metal or slag; they are dimensionally stable; they resist thermal shock; while their thermal conductivity is much higher than ceramic materials.

Future issues of CARBON AND GRAPHITE NEWS will show these properties in a variety of specific applications.

The problems of erosion, rapid wear, chemical action and sticking at the slag door have been solved at several mills by mounting a graphite sill at the door. One mill uses a piece of graphite approximately 16¼" wide x 20" long x 3⅛" thick. In addition, the slag run-out trough is lined with graphite.

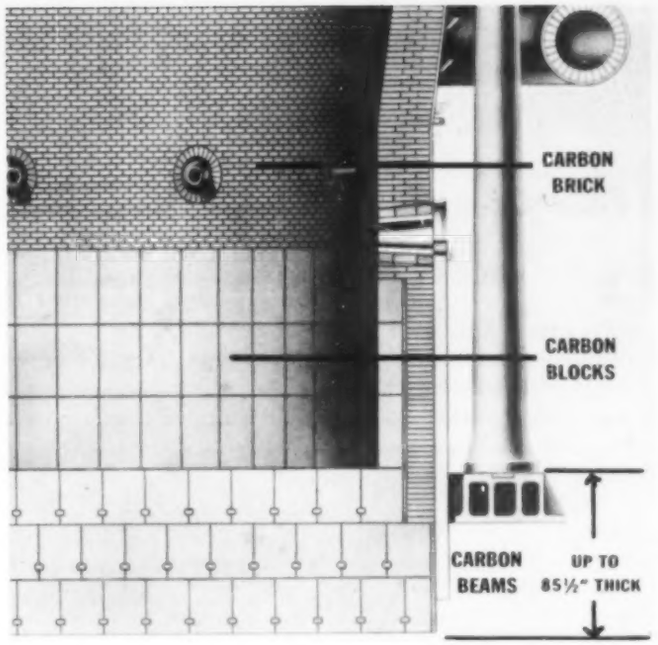
The slag does not stick to the graphite, the oxidation rate is very low and is further arrested by washing the surfaces with a clay and water slurry as soon as the slag ceases to flow. Each sill averages about twenty pours before it must be repaired.

Experience proves that the use of graphite in door sills and runners substantially increases their life, reduces the disagreeable and costly maintenance at these locations, saves time through much less frequent replacement and eliminates the extensive patching after each pour that formerly was necessary.

Blast Furnace Hearths

The early designs and installations of carbon blast furnace linings produced many very successful campaigns.

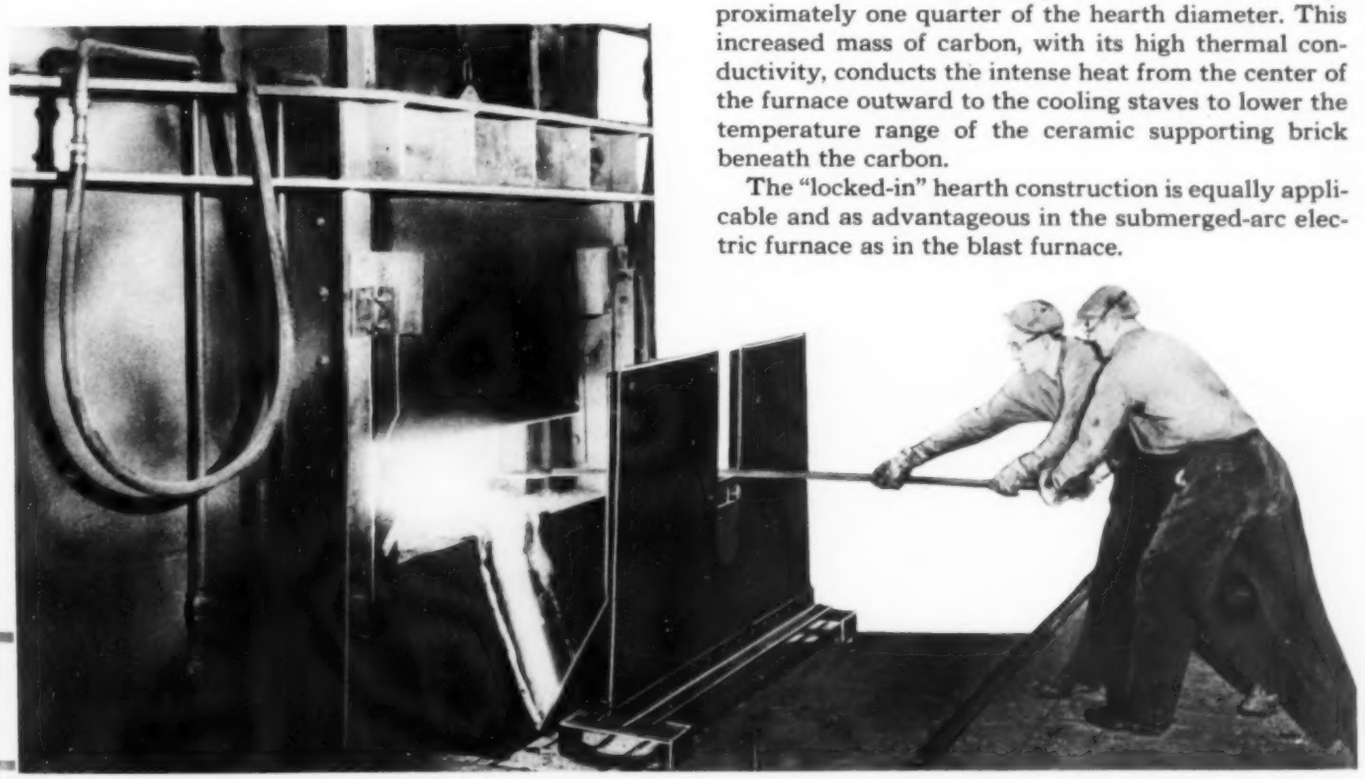
The experience and knowledge obtained from careful inspection and analysis of each furnace at the end of a campaign has been the basis for changes in the design of carbon blast furnace linings engineered by National Carbon Company to permit even more satisfactory service than before.



The horizontal hearth, in particular, retains the use of large beam sections but now adds the feature of longitudinal keys of round cross-section set into half-round keyways carefully machined in opposing faces of the vertical joints. The precision machined mating faces of each beam are coated with carbonaceous cement and the assembled hearth tightly clamped to produce an essentially monolithic carbon mass when it sets up. This provides the most practical "locked-in" construction, tieing in the blocks one to another. The 4-in. diameter rods, being joined continuously across the furnace to the cooling staves where the hearth side walls bear on this inter-locked mass of carbon beams, very positively produce an increase in mechanical strength for the entire bottom.

With this improvement in the details of construction, it is now considered more practical to increase the carbon bottom thickness up to 85½ inches, or approximately one quarter of the hearth diameter. This increased mass of carbon, with its high thermal conductivity, conducts the intense heat from the center of the furnace outward to the cooling staves to lower the temperature range of the ceramic supporting brick beneath the carbon.

The "locked-in" hearth construction is equally applicable and as advantageous in the submerged-arc electric furnace as in the blast furnace.



THE ELECTRIC ARC FURNACE

(Conclusion)

More Production Per Dollar of Investment

Increased availability results in a greater distribution of fixed charges, such as the power demand charge, investment, supervision, auxiliary services, etc. The new furnace controls, which maintain the arc a greater percentage of time and at more normal loads, have increased the load factor, reduced the surge factor and increased the power factor to further increase efficiency of operation. The new controls operate the electrodes faster and more smoothly to reduce the transfer of excessive mechanical loads upon them and prevent straining and breaking. They keep the electrodes out of the bath where they would be eroded quickly and would contaminate the charge. Mechanization has made operations easier, more consistently accurate and faster.

What is Ahead

If mechanization is carried further, as some are beginning to dream, the whole furnace operation will be programmed, recorded and automatically repeated. Can it be done? Will it be done? More fantastic things than this have been done before!

It was believed that the automatic electrode clamp could not be made practical. Now, everyone wants it on his furnace!

It was believed that electrodes could not be raised and lowered without reversing the electrode motors and that a furnace could not be controlled automatically without the usual furnace regulator. These things are being done now!

Continued exploitation of the inherent advantages of the electric arc furnace and continued development and improvement of its design will further promote the phenomenal expansion of its applications.

Credits

Charts, front cover, based on data contained in *Comparative Economics of Open-Hearth and Electric Furnaces for Production of Low-Carbon Steel*, a technical and economic study sponsored at Battelle Memorial Institute by Bituminous Coal Research, Inc., and fourteen electric utility companies; and reports of Edison Electric Institute.

Photo, inside front cover, courtesy: United States Steel Corporation.

Photo, inside back cover, courtesy: American Bridge Division, U. S. Steel Corporation.

CHARLES W. VOKAC *received his degree in engineering from the University of Illinois and has done post-graduate work in electrical engineering, metallurgy and management techniques.*

As manager, Hydro-Arc Furnace Department of the Whiting Corporation, he has travelled extensively in almost every industrial area in this country, as well as to locations in Canada, Mexico and South America. Mr. Vokac is the author of many papers on the electric arc furnace and holds patents on furnace controls and equipment.

A member of AFS, AIMME, ASME and the Society of American Military Engineers, Mr. Vokac also is active in the field of education. He is now completing his second year as President, Board of Education, Cicero, Illinois.

Clarksburg, West Virginia Works of National Carbon Company, A Division of Union Carbide and Carbon Corporation

This is the second of a series featuring the five plants of the company that are devoted to the manufacture of carbon and graphite electrodes.

The history of National Carbon Company is a chronology of "Firsts" – first with commercial production of both carbon and graphite electrodes in the early 1900's – first to introduce each succeeding larger size – first with tapered nipples and with smaller nipple sizes–first to produce carbon electrodes up to 45-inches diameter and graphite electrodes up to 35-inches diameter. Even larger electrodes and other massive shapes can be made with present facilities.

PLATE HANDLING CRANES . . by "Shaw-Box"

You will find many mills handling their plates with "Shaw-Box" Cranes. Plate handling cranes have long been another specialty in the various types of cranes that make up the well-rounded "Shaw-Box" Line of Cranes.

In "Shaw-Box" Plate Handling Cranes — whether built to an individual mill's or to A.I.S.E. specifications — you get the added advantages that come from "Shaw-Box" engineering, fine workmanship, and precision manufacturing methods. These added advantages insure crane performance that make "Shaw-Box" Cranes, for the work they do, the least expensive cranes to buy and use.

SEND ALL YOUR INQUIRIES FOR STEEL MILL CRANES AND SOAKING PIT CARRIAGES TO "SHAW-BOX".

MANNING MAXWELL & MOORE TRADE MARK

"Shaw-Box" CRANES

MANNING, MAXWELL & MOORE, INC.

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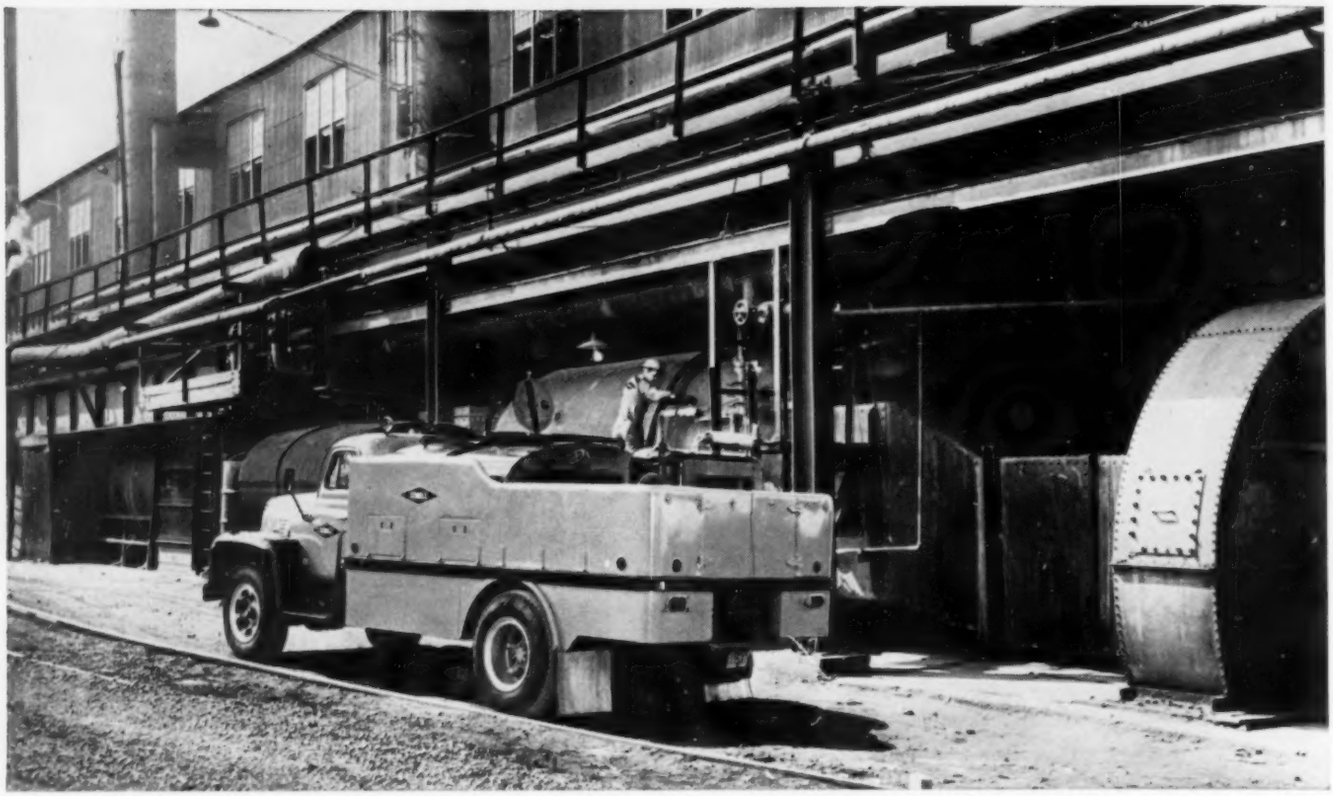
Builders of "Shaw-Box" Cranes, 'Budgit' and 'Load-Lifter' Hoists and other lifting specialties. Makers of 'Ashcroft' Gauges, 'Hancock' Valves, 'Consolidated' Safety and Relief Valves, 'American' and 'American-Microsen' Industrial Instruments and Aircraft Products.



WASTE HEAT BOILER CLEANED BY DOWELL IN 13 HOURS

Inspection after chemical cleaning showed boiler free of scale—danger of burning tubes minimized

The water side of a waste heat boiler had become fouled with scale. Cleaning of the unit was necessary to avoid the risk of burning the tubes. Dowell was called to do the job.

In just 13 hours, Dowell engineers cleaned the 6,000-gallon capacity boiler, using chemical solvents. The unit was found to be metal-clean upon inspection after the job was completed—thus the risk of burning the tubes was reduced to a minimum.

Many types of boilers, heat exchange and process equipment have been cleaned by Dowell's chemical methods . . . *without dismantling and with a minimum of downtime.* This service has saved thousands of man-hours and helped to prevent costly repairs and replacements.

Perhaps chemical cleaning could improve the efficiency of equipment in your plant. Dowell engineers do the job for you. They bring specially prepared solvents in truck-mounted tanks right to the job, along with all necessary pumping and control equipment. They apply the liquid solvents according to the technique demanded by the job: filling, spraying, jetting, cascading or vaporizing. The chemicals go wherever steam and water flow, reaching surfaces inaccessible to other methods. Often equipment may be cleaned while in operation.

A Dowell engineer will be happy to discuss your cleaning problems with you—make estimates, if you wish—no obligation, of course. For more facts about Dowell Service, call the nearest of more than 130 offices, or write directly to Department L-29, DOWELL INCORPORATED, TULSA 1, OKLAHOMA.

DOWELL SERVICE

chemical cleaning service for industry

DOWELL

A SERVICE SUBSIDIARY OF THE DOW CHEMICAL COMPANY

Date-line Diary...

November 1

▲ The AISI reports operating rate of the steel industry for the week starting November 1 is scheduled at 75.7 per cent of capacity. This is equivalent to 1,804,000 tons compared with 1,776,000 tons one week ago and 2,096,000 tons one year ago. Index of production for the week is 112.3.

November 2

▲ General Motors Corp. granted a $2.00 year-end dividend for 1954 compared with $1.00 the previous year. This brought the total payments for 1954 to $5.00 compared with $4.00 in 1953.

▲ Follansbee Steel Corp. adopted a proposal to sell the firm's assets to Frederick W. Richmond of New York for $9,200,000 and to merge the remaining structure with two firms controlled by Clint W. Murchison of Texas.

November 3

▲ The Federal Reserve reported consumer installment credit outstanding during September rose to $21,300,000,000. This rise was much lower than the $129,000,000 gain in September of 1953.

▲ Iron ore shipments, to date in 1954, amounted to 57,800,000 tons, 39 per cent below the like 1953 period.

November 4

▲ Exports in the United States declined to $975,000,000 in September, down $76,000,000 from one year ago.

November 5

▲ Wheeling Steel Corp. announced increased monthly pensions will be paid to employees who retire on or after November 1, 1954, plus other pension benefits.

▲ The Commerce Dept. reported personal income in September ran at an annual rate of $287,500,000,000, 1 per cent below the record high of $288,200,000,000 in July 1953.

▲ Construction expenditures in October totaled $3,500,000,000, down 3 per cent from the previous month but 8 per cent above October of 1953, as reported by the Commerce and Labor Depts.

November 8

▲ According to the Commerce Dept., stocks of manufacturers, wholesalers and retailers were valued at $77,400,000,000 as of September 30, a rise of $82,000,000 over August but $4,300,000,000 below the corresponding 1953 period.

▲ The AISI reported operating rate of the steel industry for the week starting November 8 is scheduled at 77.2 per cent of capacity. This is equivalent to 1,842,000 tons compared with 1,822,000 tons one week ago and 2,081,000 tons one year ago. Index of production for the week is 114.7.

November 9

▲ Factory employment in the month ending October 15 rose from 16,019,000 to 16,036,000 due to the recalling of auto workers for the 1955 models, contrary to the normal seasonal decline.

▲ The Aluminum Association reported primary production of aluminum in September 1954 totaled 240,664,643 lb compared with 250,592,575 lb in August and 218,666,531 lb in September 1953. The total third quarter production of 743,581,012 lb represents a new all-time high.

November 10

▲ The Agriculture Secretary feels that Congress should drop price supports to 75 per cent of parity in 1956. Present supports are between 81½ and 90 per cent.

▲ Cyrus Eaton has purchased 213,467 shares of Portsmouth Steel Corp. common stock from Allegheny Corp. This represents around 19 per cent of the total Portsmouth Steel stock outstanding.

▲ U. S. Steel Corp. plans to construct a $20,000,000 anhydrous ammonia plant at its Geneva, Utah works in the early part of 1955. The plant will go into operation in 1956 with capacity output of 70,000 tons of ammonia per year.

November 11

▲ Electricity output last week hiked to a record 9,357,000,000 kwhr. This was 11.4 per cent above the like period in 1953.

November 12

▲ The October total of F. W. Dodge Corp. reports was the third highest monthly total in Dodge history with $1,965,339,000, for construction contract awards in the 37 states east of the rockies which is 8 per cent above September and 4 per cent above October 1953.

▲ Applications by home buyers for mortgage insurance from the Government in October amounted to 59,530, over double the 1953 figure.

▲ Jean Monnet announced his resignation effective February 10, as president of the European coal-steel pool's high authority which is a nine-member executive committee. He held this position for two years.

November 13

▲ According to the Bureau of Mines, consumption of ferrous scrap during September totaled 4,297,000 tons compared with 4,164,703 tons in August.

▲ According to Thomas S. Holden, vice chairman of F. W. Dodge Corp., construction activity in 1955 will set another new all-time high.

November 15

▲ The AISI reported operating rate of the steel industry for the week starting November 15 is scheduled at 78.9 per cent of capacity. This is equivalent to 1,882,000 tons compared with 1,874,000 tons one week ago and 2,044,000 tons one year ago. Index of production for the week is 117.2.

▲ Stocks of auto dealers' new cars fell to 250,000 at the end of October. This was a reduction of 186,000 from the previous month and 302,000 below the year earlier period.

▲ According to the Commerce Dept., national production of goods and services in the third quarter fell to a yearly pace of $355,500,000,000. This was $500,000,000 below the rate for the second quarter and compares with $367,200,000,000 for the third quarter in 1953.

▲ Work started on 106,000 home units in October, a new high for the month, which was 7 per cent down from the total in September but 18 per cent above the figure in October 1953.

November 16

▲ According to the Commerce and Labor Depts., construction outlays during 1955 should set a new high for the ninth consecutive year. They estimate about $39,500,000,000 or about 7 per cent higher than 1954.

▲ Corporate dividend payments in October totaled $594,200,000, up $40,900,000 from one year ago, as reported by the Commerce Dept.

▲ The Portsmouth, Ohio Div. of Detroit Steel Corp. is presently operating its four open hearth furnaces due to increase in demand for steel sheets and large orders for rod and wire products.

November 17

▲ According to a report of the ARCI, deliveries of new domestic freight cars in October totaled 1817 compared with 2566 in September and 8727 in October 1953. New orders placed in October totaled 2704 freight cars. Backlog of cars on order as of November 1, 1954 was 12,853 compared with 11,993 on October 1.

▲ The AISI reported output of alloy ingots and steel for castings in October totaled 632,342 net tons compared with 565,317 tons in September and 662,780 tons in October 1953.

November 18

▲ Benjamin F. Fairless, chairman of U. S. Steel Corp., predicts steel production in 1955 will be 5,000,000 to 10,000,000 tons above the 86,000,000-ton output expected in 1954.

▲ Republic Steel Corp. acquired coal mining properties of Ford Colleries Co. near Pittsburgh which adjoins Republic's Russellton mine.

November 19

▲ According to Clifford F. Hood, president of U. S. Steel Corp., most steel users are now rebuilding their stocks since living from their inventories earlier this year.

▲ The Aluminum Association reported primary aluminum production in the United States totaled 250,178,989 lb in October compared with 240,664,643 lb in September and compared to 216,438,214 lb in October one year ago.

November 22

▲ Unemployment claims in the week ending November 13 dropped to 247,100, off 19,300 from the preceeding week. The year earlier claims amounted to 274,000.

▲ The gross national product is expected to hit $355,500,000,000 this year, the second highest in any year.

▲ The AISI reports operating rate of the steel industry for the week starting November 22 is scheduled at 79.3 per cent of capacity. This is equivalent to 1,890,000 tons compared with 1,892,000 tons one week ago and 1,956,000 tons one year ago. Index of production for the week is 117.7.

November 23

▲ Foreign Operations Administrator, Stassen, advocated that west Europe join the U. S. in a large Asian development program which would be somewhat similar to the Marshall plan.

▲ A report of the Commerce Dept. stated that U. S. companies and individuals raised their direct investment in foreign business operations from $7,000,000,000 in mid-1946 to $17,000,000,000 in mid-1954.

November 24

▲ The International Nickel Co. of Canada, Ltd. announced an increase of 4½¢ per lb in the price of refined nickel. This brings the U. S. price to $0.64½ per lb.

▲ Youngstown Sheet and Tube Co. plans to spend about $5,000,000 in modernizing its cold strip department of the Campbell Works, Youngstown, Ohio. The expansion will increase capacity and will enable the department to handle larger coils thus improving efficiency in customers' plants.

November 26

▲ Government experts look for farm income totaling about $12,000,000,000 in 1955, off 4 per cent from the indicated figure for this year.

▲ Steel scrap prices dropped in the Pittsburgh district as a major steel producer bought some No. 1 heavy melting scrap at $33 a ton, off $1.00.

▲ The AISI reports operating rate of the steel industry for the week starting November 29 is scheduled at 80.5 per cent of capacity. This is equivalent to 1,919,000 tons compared with 1,915,000 tons one week ago and 1,972,000 tons one year ago. Index of production for the week is 119.5.

November 29

▲ Lee Higginson Corp. announced the successful completion of the offering of 599,215 shares of Barium Steel Corp. which was offered in the ratio of one share of new stock for each four shares held.

▲ The AISC reported October bookings of fabricated structural steel amounting to 206,761 tons, about the same as the previous month and 8 per cent greater than the corresponding month of last year. Bookings for the first ten months totaled 2,110,764 tons. Shipments in October totalled 254,507 tons and backlog of work ahead as of October 31 stands at 1,293,779 tons.

November 30

▲ The proposed sale of Follansbee Steel Corp.'s assets for $9,286,620 to the Frederick W. Richmond group of New York was declared void by U. S. court as a result of a stockholders' petition which opposed the sale chiefly because it would move most of the equipment to Gadsden, Ala., and would leave several hundred residents of Follansbee jobless.

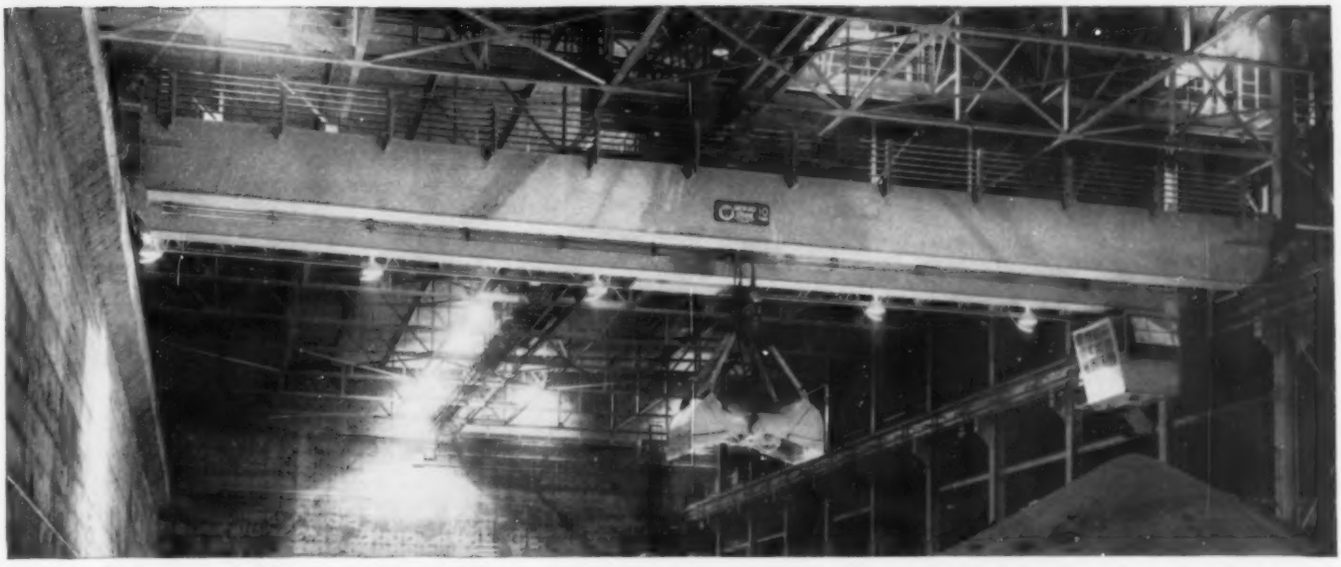
▲ From 1945 to 1953, annual shipments of steel to the oil and gas industry rose from 2,063,000 net tons to 5,455,000 tons.

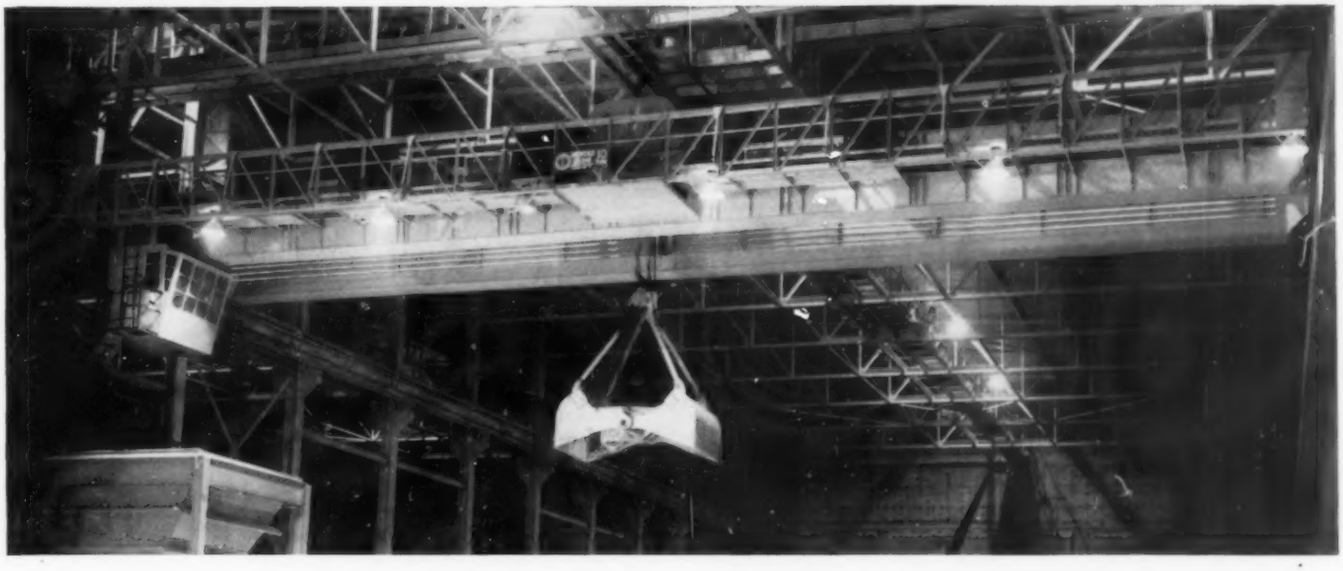
▲ No. 1 dealer heavy melting steel scrap dropped $1.00 a ton in chicago to the price of $33.00 following the same decline in Pittsburgh one week previously.

▲ Operating rate of the steel industry in the Buffalo area has reached a 100 per cent capacity compared with the low of 56.2 per cent during the summer months.

▲ Kennecott raised prices on all copper products by $0.38 per lb and also advanced quotations on brass and bronze products by $0.43 to $0.55 a lb.

▲ Farm prices advanced 0.8 per cent during the mid-October and mid-November period with vegetables, eggs, milk and wheat leading the rise, thus reversing a downtrend.





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In the steel industry, as throughout all industry, more and more important producers are specifying Bedford Cranes.

The big swing to Bedford Cranes is further evidenced by the high percentage of repeat orders from experienced crane users who require and *expect* superior performance.

Backed by more than half a century of *specialized* crane engineering and fabricating experience . . . Bedford Cranes have won fame the world over for advanced design and for safe, smooth, dependable performance.

Available in all types and sizes . . . from 5 tons to 350 tons . . . for all kinds of indoor and outdoor service . . . each Bedford Crane is individually engineered for its specific application.

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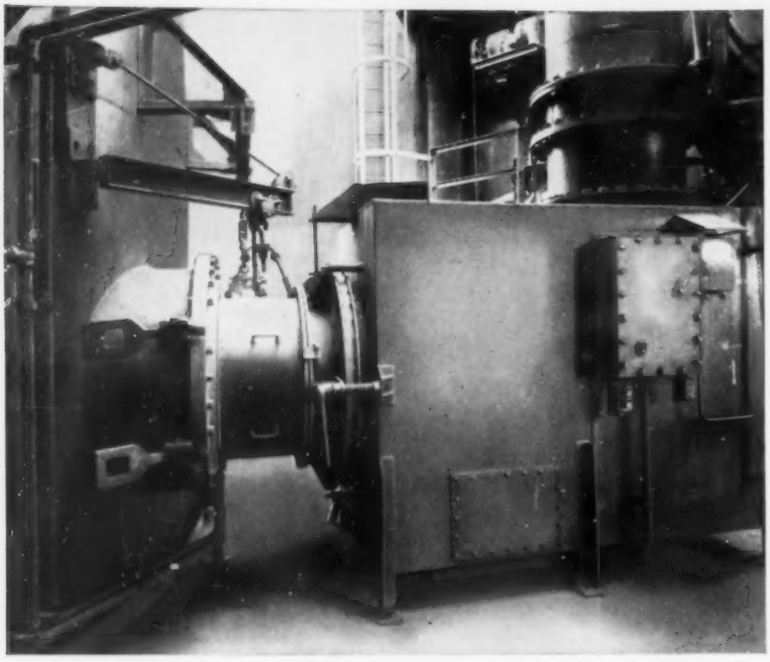

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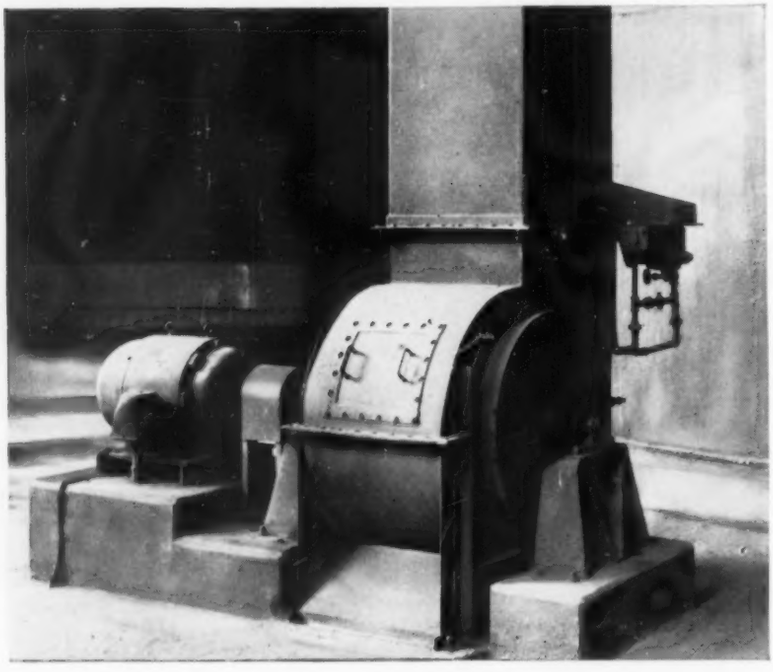

*

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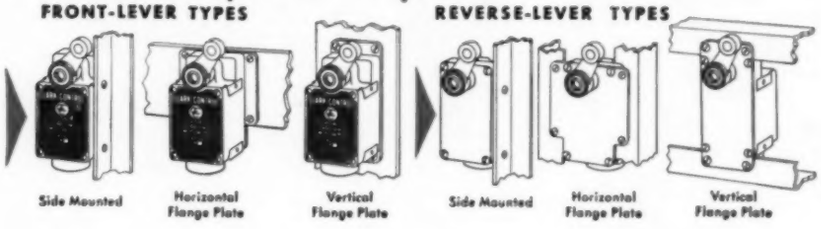
NEW!

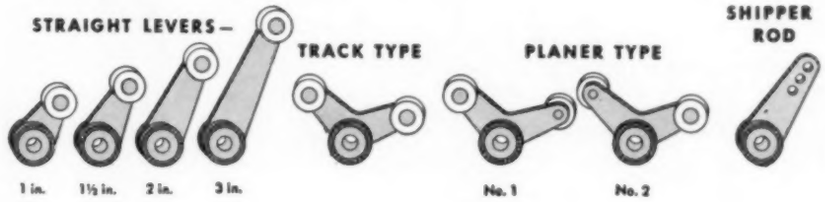
CLARK *Type DM* MACHINE LIMIT SWITCH

• This new heavy-duty limit switch is built with a minimum of moving parts, and with emphasis on simplicity of construction. The primary objective in its design is to provide dependable, accurate, trouble-free operation for a long life. All latch and trip-bearing surfaces are nylon to steel for minimum wear. All springs are in compression for greatest safety—they cannot be overloaded. This and other features make the switch as nearly fail-safe as possible.

Mounting Arrangements



Operating Levers



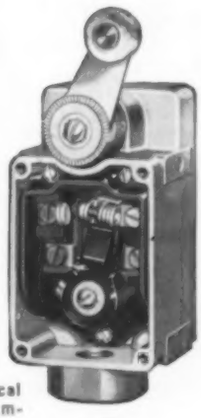
Nylon roller cushions impact, has low friction coefficient and long wearing qualities.

Reversible operating lever. Simple screw driver adjustment for reversing or positioning.

Heavy molded insulating chamber surrounds all live parts and provides ample wiring space for four No. 12 wires with Stakon connectors.

Areas subjected to arcing are protected by glass-melamine plates.

Electrical and mechanical sides of switch are completely isolated.



Nema Type 5 dust-tight, oil-tight enclosure of heavy die-cast construction.

Double-concentric overtravel springs in compression for fail-safe operation.

Return spring is in compression. Can be changed without tools to either side of arm, or removed for maintained contact.

Spring-loaded latches are nylon for low friction and long life.

Choice of ½" or ¾" conduit opening.

Write for Bulletin 102DM

The **CLARK CONTROLLER** *Company*

Engineered Electrical Control

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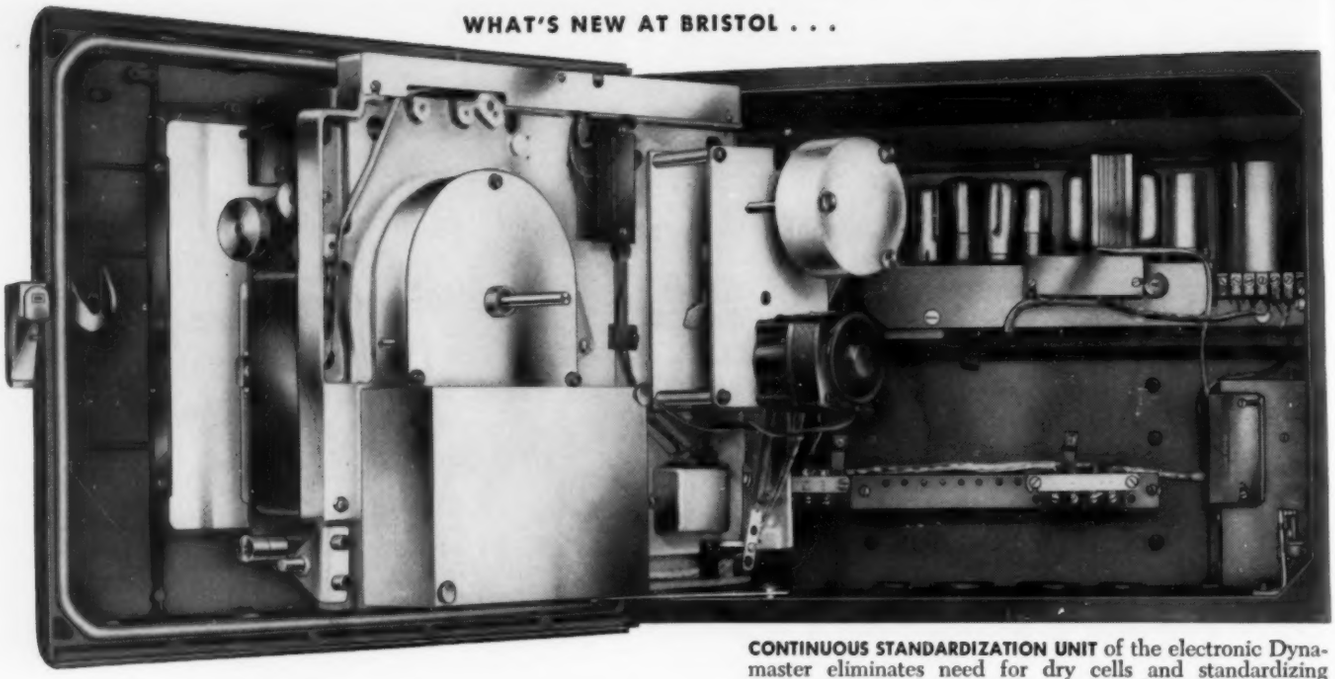
WHAT'S NEW AT BRISTOL . . .



CONTINUOUS STANDARDIZATION UNIT of the electronic Dynamaster eliminates need for dry cells and standardizing mechanism. Result: no interruptions in the operation of the potentiometer for standardization; no batteries to replace.

No time out for standardization here

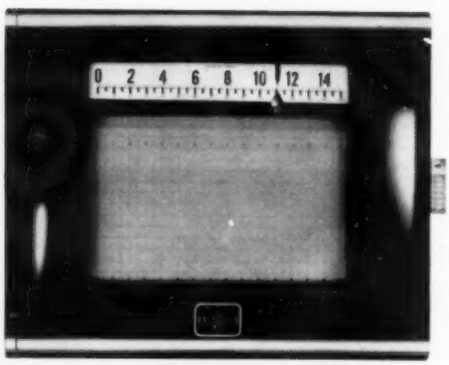
Bristol Dynamaster potentiometer pyrometers give you No-Batt continuous standardization

• You don't have to put up with interrupted performance from old-fashioned potentiometer pyrometers any longer!

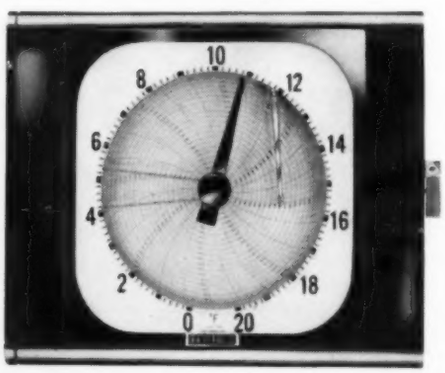
When you use a Bristol thermocouple or radiation-type Dynamaster, you get a *continuous* record or control of temperatures up to 4000°F in any type of fuel-fired or electric furnace or heating equipment. Thanks to the exclusive No-Batt continuous standardization which eliminates the need for dry cells in these electronic instruments, Bristol has been able to do away with interruptions formerly required for periodic standardization.

Bristol electronic Dynamasters are made in round- and strip-chart, single- and multiple-record recorders, air-operated and electric controllers with all types of control actions. Two-pen and program control.

For the complete story on the modern human-engineered Bristol Dynamaster, write for free 35-page booklet P1245. The Bristol Company, 123 Bristol Road, Waterbury 20, Conn.



BRISTOL DYNAMASTER CONTROLLERS in either the strip-chart model (shown above) or round-chart model, may be electrically or air operated. 2 position, 3 position, proportional, manual with automatic reset, or proportional input controls. On - off, proportional or reset air controls.



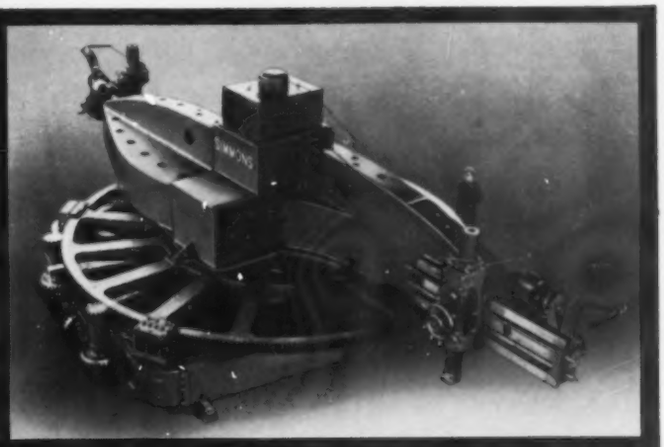
BRISTOL DYNAMASTER RECORDERS come in easy-to-read round-chart (shown here) or strip-chart models. Single record, multiple record or continuous 2 record designs are available. Bristol also supplies all types of time-temperature program controllers.

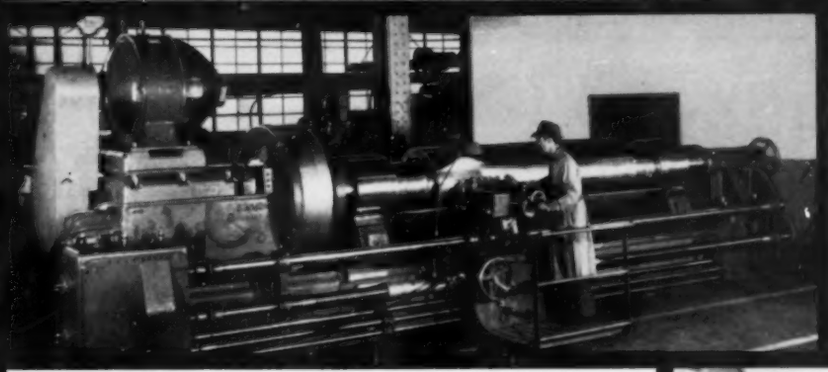
BRISTOL

POINTS THE WAY IN HUMAN-ENGINEERED INSTRUMENTATION

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

"Special Purpose" machine tools





↑
36' Circular Boring Mill, designed and built by Simmons for machining the forged steel turrets of battleship guns.

←
Lathe cuts indentations in tough alloy steel rolls used to produce steel safety floor plate. Simmons designed and built the tool for a leading steel producer.

Unusual Pit Lathe was especially designed for the machining of large dryer rolls. Lathe handles rolls up to 14' diameter on 30' centers.
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Labor costs are up...profit margins slimmer. What's the answer? Just this:

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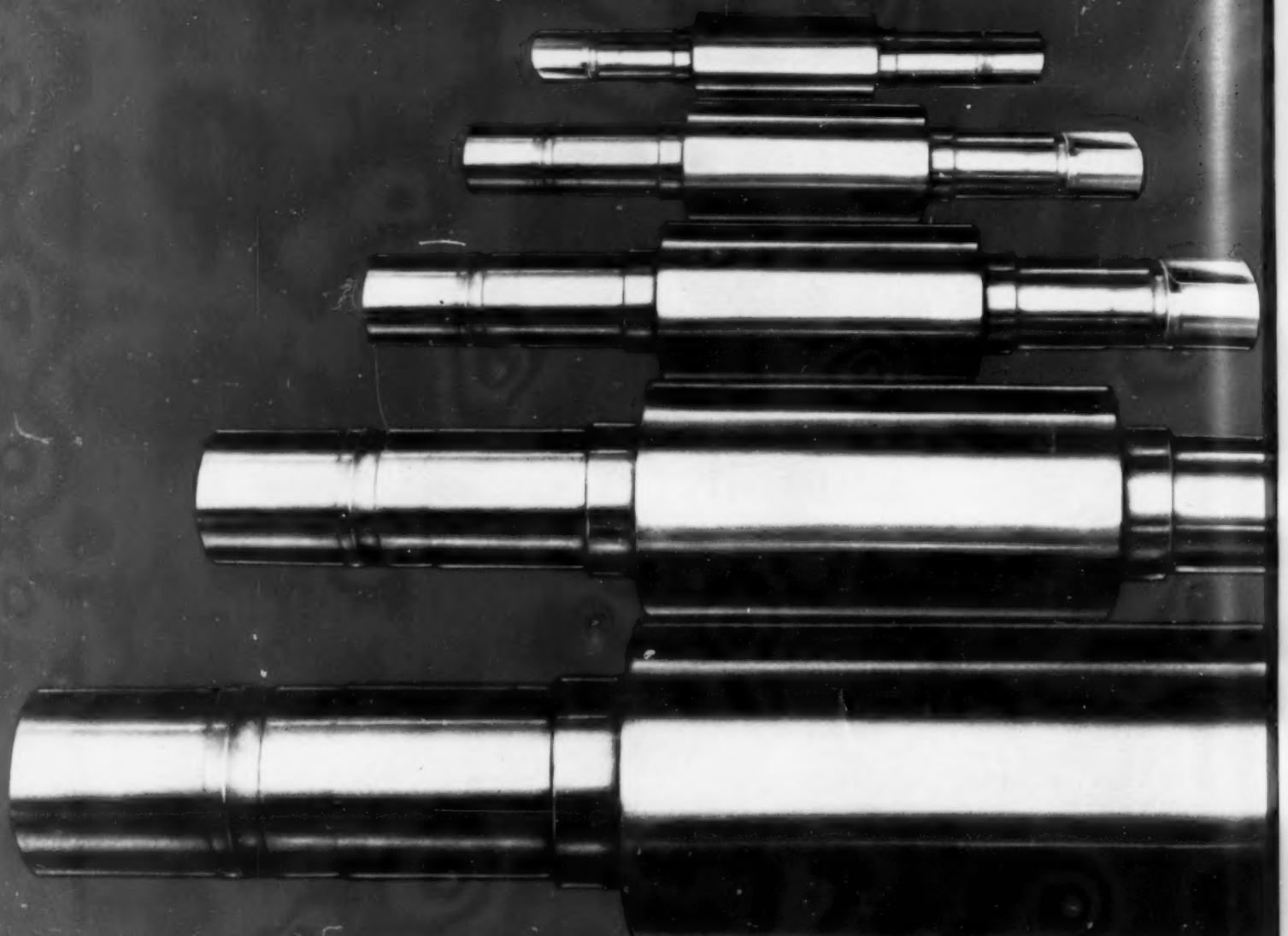

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Industry News...

U. S. STEEL CORP. INSTALLS MODERN INGOT MOLD FOUNDRY AT EDGAR THOMSON WORKS

▲One of the most modern ingot mold foundries in the industry is now complete at U. S. Steel Corp.'s Edgar Thomson Works.

Capable of producing 275,000 tons of ingot molds annually, the foundry will supply the molds for the corporation's basic steel mills in the Pittsburgh-Youngstown District and for Fairless Works. Occupying a two-acre area near the blast furnaces, the new facilities span the entire cycle of ingot mold production from sand storage to finished casting.

The new foundry increases Edgar Thomson's ingot mold capacity in both range of product and total output. Operated entirely by electrical power and utilizing latest material handling equipment, it is capable of making molds weighing up to 35 tons and as high as 110 in.

The foundry uses a silica base sand of superior heat resistant characteristics. Although much more expensive than river sand, this higher grade material, mixed with a bonding material known as Bentonite, improves the quality of ingot molds by providing smoother and cleaner inside surfaces.

Belt conveyors move the sand to the foundry from bins housing 100 tons of new sand and 200 tons of reclaimed sand, with reserve space for 250 additional tons. Bucket elevators, feeders, screens, a 25-ton crane and other modern equipment complete the sand handling facilities.

Before this new installation was placed in operation, molders rammed sand by hand between iron and wood patterns to make the molds. After hand-ramming, the molders packed the wet sand with air tampers in another laborious job.

Now the sand is packed into the patterns by newly developed machines known as "sand slingers" with such force that no manual ramming is needed. These mobile units, equipped with 20-ton tanks, can ram sand at the rate of a million pounds every 24 hr. Resembling traveling gun turrets, they move the entire length of the foundry on standard gage railroad tracks between four revolving turntables where the molds are prepared. It is believed that this is the first application of such turntables in an ingot mold foundry.

The sand cores and flasks are conveyed to one of eight re-circulating down-draft ovens for drying at closely controlled temperatures up to 750 degrees. These drying ovens can handle more than 1000 tons of molds daily. Overhead cranes carry the sand molds from the ovens to the pouring stations.

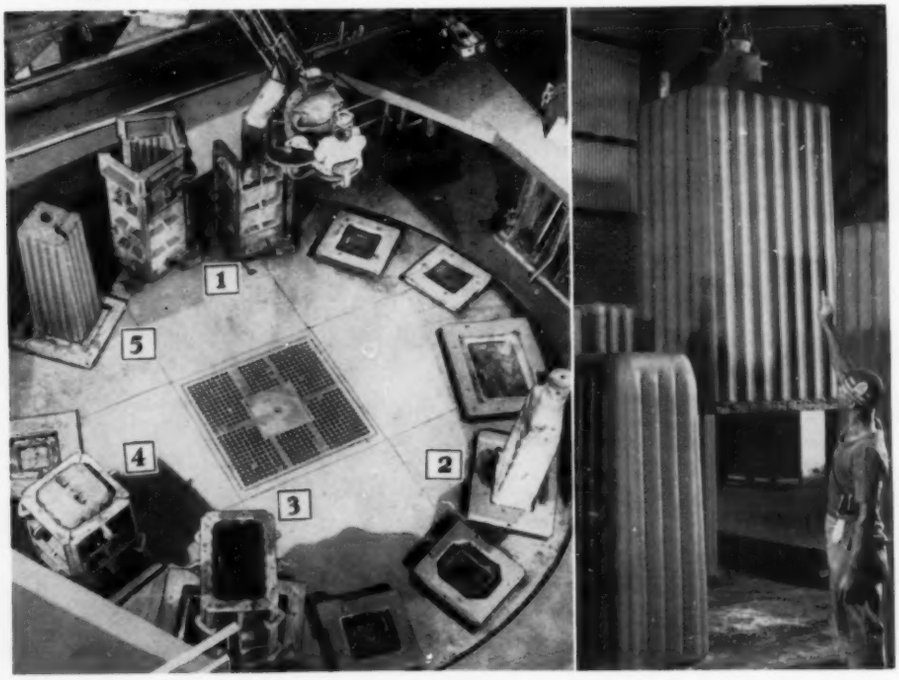
Metal handling is somewhat simpler than mold preparation. Electrically tilted ladles deliver blast furnace iron to 20-ton casting ladles, which, in turn, travel by crane to the pouring stations. Casting, a precision operation, takes place at one of three pouring stations, each accommodating 40 molds.

After they have cooled and solidified, the ingot molds are removed from the flasks and cores in which they were cast. Known as "shake out," this process is conducted at two locations, both equipped with dust handling facilities which keep foundry dust to a minimum. Five dust collectors clean the dust laden air at the rate of 168,000 cu ft per minute.

The heating and ventilating systems are designed to provide pleasant working conditions. Sixteen exhaust fans, each moving 66,000 cfm of air, can change the air 14 times an hour within the buildings.

Long a principal ingot mold producer, Edgar Thomson dismantled buildings and equipment in use over 50 years to make way for this new installation.

Shown clockwise, at left, are five stages of ingot mold core production on one of four turntables at U. S. Steel's Edgar Thomson Works. Shown are; partially assembled core boxes (1); core barrel (2) which will be inserted in finished core box (3); core rammed by sand slinger (4); completed ingot mold core (5). Awaiting shipment to drying ovens (right) cores will shape ingots weighing up to 35 tons.



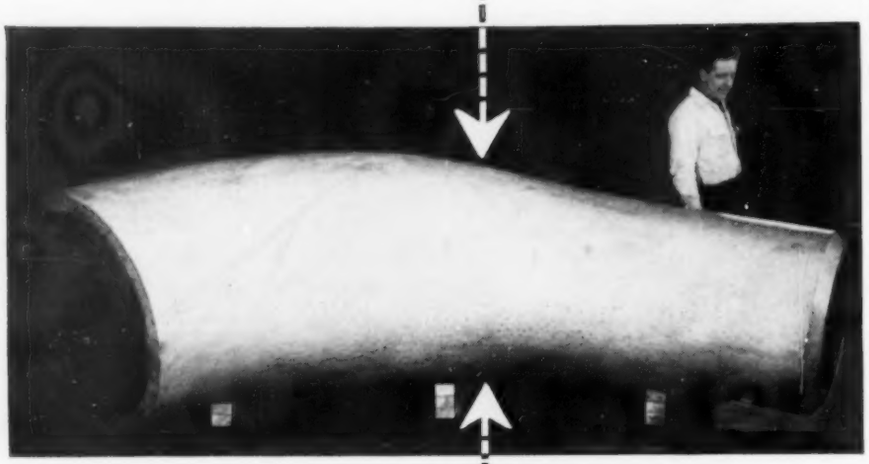
RELINED BLAST FURNACE OPERATING AT WEIRTON

▲ Weirton Steel Co.'s No. 2 blast furnace is back in production following a shutdown for relining and other repairs.

Work on the furnace, which was shut down in September after operating continuously for nearly seven and one-half years, was completed and the furnace blown in on Nov. 14.

DURALOY

This Casting



Set a Record!

Casting weight
21,000 pounds

Shipping weight
14,000 pounds

Alloying Elements
38% Ni., 18% Cr., 2% Mo.

It's the weight rather than the Ni-Cr content that's the record.

We've cast many a piece with such a high Ni-Cr combination. But this represents the largest casting we have ever made. And it took careful scheduling of our entire battery of electric furnaces, with a double melt from two smaller furnaces.

Next followed a thorough X-ray for hidden flaws with our 400,000 volt unit. Then rough-finishing to specifications.

The significant fact is that this casting, the first of this size we have ever produced and destined for a most important high priority processing job, passed inspection with flying colors. *There was no reject here.* It is indicative of the skill of our metallurgists and foundrymen in turning out high alloy castings.

If you are looking for this kind of service, make Duraloy your casting source.

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Prior to the shutdown, No. 2 had produced 3,335,257 tons of iron from the time it was last blown in on April 24, 1947.

In addition to relining the project included installation of automatic handling and filling equipment of the same type now in use on Weirton Steel's other three blast furnaces.

COLD MILL TO COMPLETE EXPANSION AT EMPIRE

▲ Empire Steel Corp, announced that it will put a new cold mill into operation during the first quarter of 1955. It will mark the final step in a five-year, $20,000,000 expansion program.

The new mill will be housed in recently completed structures containing 100,000 sq ft of floor space.

Completion of the expansion program will enable Empire to ship approximately 300,000 net tons of products annually. All material turned out at the plant will be finished, nearly doubling the company's production of this type of goods.

Reeves Steel and Manufacturing Co., which is closely related to Empire through stock ownership, recently announced a $3,000,000 expansion and modernization program. A continuous hot die galvanizing line will be the principal addition to existing facilities.

REPUBLIC ACQUIRES FORD COLLERIES CO.

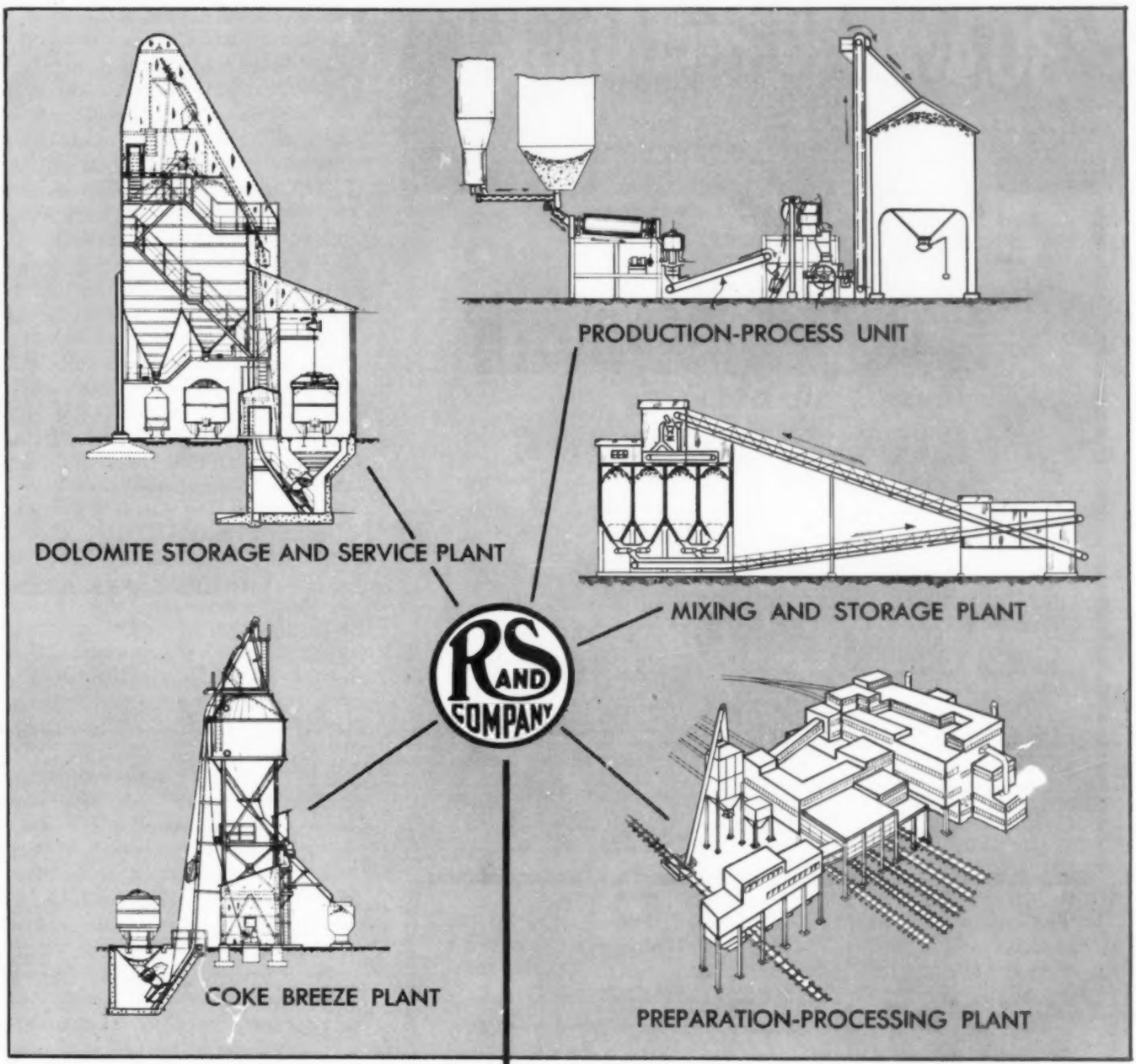
▲ Republic Steel Corp. has acquired the coal mining properties of Ford Colleries Co. near Pittsburgh.

The property adjoins Republic's Russellton, Pa., mine on the northwest and consists of two mines, Francis and Berry, neither of which has been operated for more than 18 months.

Plans call for Republic to expand its Russellton operations into the new property as soon as possible, bringing the coal up the Russellton shaft and processing it through the Russellton coal washing plant.

The transaction strengthens Republic's reserves in the Freeport Seam in the Allegheny Valley. Republic for many years has operated the Russellton and Indianola mines in the Freeport area and in 1952 acquired the Newfield Mine.

Designed and built to reduce per ton handling cost



Bulk materials can be handled at reduced cost by properly designed storage and service plants incorporating improved modern equipment.

Roberts & Schaefer Company designs—engineers and constructs—and builds such plants, and has the knowledge and experience to effect greater efficiencies and savings.

If you have bulk materials that are processed, hoisted, transported or stored, R & S complete service can help you. Main and District Offices conveniently located for consultation.

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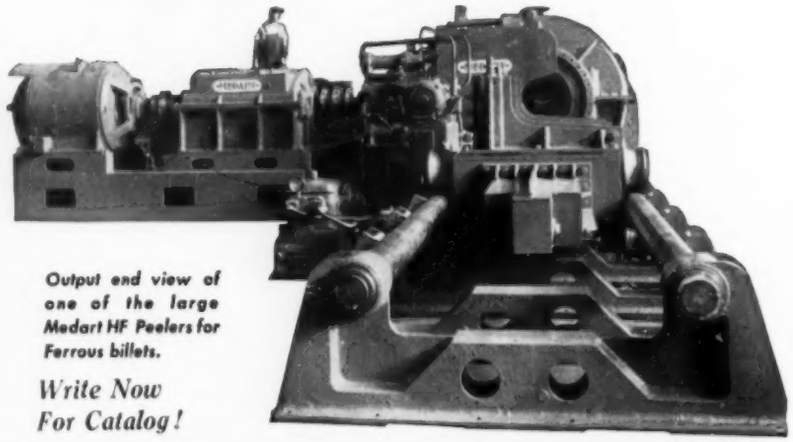
Billets Peeled at 20', 30', even 40' Per Minute!

MEDART

MODEL HF

BILLET PEELERS



Output end view of one of the large Medart HF Peelers for Ferrous billets.

Write Now For Catalog!

- The output of Medart Billet Peelers is limited only by the capacity of the best available cutting tools! That means the absolute maximum in production at the lowest possible cost!
- Built to handle both ferrous billets from 1" to 14" diameter—as well as brass, copper, aluminum and other non-ferrous metals.
- Throughput speeds of these Medart Peelers range from 1' to 40' per minute, depending upon workpiece size and material.
- Can be equipped with either one or two cutterheads—arranged for high surface finish or heaviest hogging cuts.
- Furnished with hydraulic or pneumatic controls, with push-pull feed devices, and for completely automatic operation.
- No other scalping or turning machines made can match the production speed or economy of Medart's complete line of Billet Peelers.

CONTINENTAL FOUNDRY & MACHINE CO.

220 GRANT STREET PITTSBURGH 19, PA.

The mines are located in a favorable freight zone for shipment to the by-product coke ovens in Republic's Ohio steel plants.

BLAW-KNOX TO BUILD TANK TURRETS FOR ARMY

▲ Union Steel Castings Division of Blaw-Knox Co., working on a subcontract with Chrysler, will make half of the cast steel turrets for Army medium tanks to be produced in 1955.

The multi-million dollar contract marks the continuation, rather than the beginning, of tank turret casting and machining. Now nearing completion is a contract with the Cadillac Division of General Motors for medium tank turrets, which will free more than enough production facilities to handle the new order.

In addition to casting and machining the turrets, Union Steel Castings will make about one-third of the gun shields in the coming year.

FURTHER CONSOLIDATES BRIDGE FABRICATION

▲ Further consolidation of bridge fabrication was announced by U. S. Steel Corp.'s American Bridge Division with the integration of "I-Beam-Lok" bridge flooring fabrication into its Ambridge, Pa. operations.

The change will involve the transfer of equipment from McDonald Mills of the corporation's Youngstown District Works which has produced this light-weight bridge flooring since 1944. The Youngstown District will continue to produce and roll the steel for this product.

Movement to Ambridge will have a stabilizing influence on employment in this operation. The irregular and seasonal demand for bridge flooring placed an uneven load on the operation and the resulting expansions and contractions of working forces created a problem for both employees and mill management at Youngstown. At Ambridge the work will be combined with other job contract work, much of it welded work of a similar nature, so that more steady employment should result.

When the operation gets underway at Ambridge early next year, it is expected that former production of six to eight thousand tons annually may

be exceeded, increasing demand for rolled steel sections from Youngstown District Works.

GLOBE STEEL TUBES CO. PURCHASED BY B&W

▲ The Babcock & Wilcox Co. has purchased the assets and business of the Globe Steel Tubes Co., Milwaukee, Wisc., for approximately $9,300,000.

Terms of the transaction were approved by the boards of directors of both companies. Stockholders of Globe Steel will get cash for their holdings.

Babcock & Wilcox announced that it will continue to operate the Milwaukee plant as a part of its Tubular Products Division. The sale needs approval of the Globe Co. stockholders before becoming final. Kalman & Co., Inc., Minneapolis, Minn., has been retained by Globe to aid in the consummation of the plan.

Operations at the plant will continue without interruption and present production personnel will be retained.

Globe Steel manufactures seamless and welded stainless, alloy and carbon steel tubing as well as a variety of aircraft tubing, pressure tubing and welding fittings.

CAMPBELL WORKS BLAST FURNACE "A" BLOWN IN

▲ Blast furnace "A" at the Campbell Works of the Youngstown Sheet and Tube Co. was blown in on Nov. 26, after being idle since January 3. Now on its ninth campaign, the 46 year old furnace has produced more than 10,500,000 tons of iron. Its daily capacity is 875 tons.

AMMONIA PLANT DESIGN NEARS COMPLETION

▲ Engineering design of a 200-ton-per-day ammonia plant to be built by United States Steel Corp. at its Geneva, Utah, plant, is nearing completion, according to Blaw-Knox Co.'s Chemical Plants Division.

Construction on the new plant, which will have a capacity of 70,000 tons of ammonia annually, is scheduled to begin early in 1955. Actual production will begin in 1956.

United States Steel will produce anhydrous ammonia and ammonium nitrate for the expanding industrial and agricultural markets in the Intermountain and Pacific Northwest areas. The coke oven gas being produced at the Geneva plant will be used as the source of hydrogen in the ammonia plant.

DRAVO TO CONTINUE AS TRI-LOK DISTRIBUTOR

▲ The Machinery Division of Dravo Corp. will continue as national distributor for certain products of the Tri-Lok Co., recently purchased by the Blaw-Knox Co. and now operated as one of the latter company's divisions.

Although the outstanding capital stock of Tri-Lok has been acquired by Blaw-Knox Co., there is no change in the product distribution organization.

Dravo, which has represented Tri-Lok for the past 26 years will continue to market mechanically interlocked ferrous and non-ferrous flooring, concrete armoring, and safety steps, as well as Tri-Forged welded steel grating and stair treads.

FIVE YEARS SERVICE WITH MINIMUM REPAIRS TO WALLS AND ARCHES!
FOR ECONOMICAL SOAKING PIT INSTALLATION SPECIFY BUCKEYE!
● Buckeye Silica Firestone holds heat longer—provides greater savings in fuel! It has greater than usual strength to resist abrasion—saves repair costs! Its corrosive resistance guards against chemical attacks of slag—makes it last longer!
Other important features make Buckeye Silica Firestone ideal for the solution of your soaking pit problems. Write us for full information.
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BUCKEYE
"FOR THAT EXTRA SERVICE"
SILICA FIRESTONE

Johns-Manville announces the development of new **SIL-O-CEL 16L** *Insulating Fire Brick . . .*

Lompoc, California, where Johns-Manville mines and processes diatomaceous silica insulating materials

Combines outstanding physical and thermal properties for furnace service to 1600F

Check these properties of SIL-O-CEL 16L

Maximum service temperature	1600F, back-up or exposed
Approximate density	33-35 lb per cu ft
Transverse strength	60 psi
Cold crushing strength	350 psi
Linear shrinkage	0.7 percent at 1600F
Reversible thermal expansion	less than 0.1 percent at 1600F
Thermal conductivity (Btu in. per sq ft per F per hr at indicated mean temperatures)	0.92 at 500F 1.07 at 1000F 1.22 at 1500F

1—has less than 0.1% reversible thermal expansion at 1600F

2—provides high load-bearing strength

3—for direct exposure or back-up service

Here is a new development of Johns-Manville insulation and refractory research. Its exceptional characteristics provide important savings in furnace construction. Made of diatomaceous silica, Sil-O-Cel* 16L Insulating Brick is light in weight . . . has low thermal conductivity . . . high structural strength. And where furnace linings are subjected to severe heat shock or where high load-bearing properties are needed, Sil-O-Cel 16L offers outstanding performance.

Sil-O-Cel 16L is now available. Samples will be sent on request. Also available without obligation is Booklet IN-115A, which describes Sil-O-Cel 16L and other J-M Insulating Brick and Insulating Fire Brick for service to 3000F. Write Johns-Manville, Box 60, New York 16, N.Y. In Canada, 199 Bay Street, Toronto 1, Ontario.

*Sil-O-Cel is a Johns-Manville registered trade mark

Replaces SIL-O-CEL Natural Brick

The development of Sil-O-Cel 16L Insulating Brick has resulted in the discontinuance of Sil-O-Cel Natural Brick. The outstanding properties of Sil-O-Cel 16L make it the ideal replacement for Sil-O-Cel Natural Brick for back-up use. In addition, the properties of Sil-O-Cel 16L Brick extend its use to exposed service applications.

JM

Johns-Manville *FIRST IN* INSULATION

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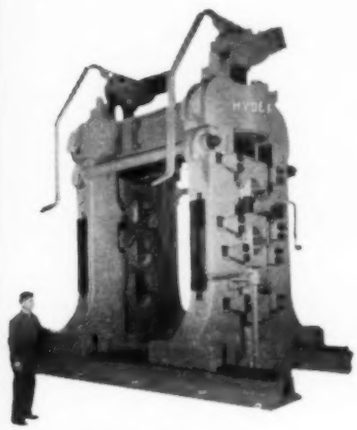
Hyde Park

RED CIRCLE Rolls ALLOY-CHILLED

Rolling Mill Equipment

Outstanding in quality and in performance Hyde Park Rolling Mill Equipment has enjoyed the respect of the industry for more than fifty years.



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Guillotine Shears
Sheet Mill Shears
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ROLLS
ROLLING MILL MACHINERY
GREY IRON CASTINGS

CHANGE OF LOCATION ANNOUNCED BY DREVER

▲ Drever Co. announces a change in location. New facilities have been established at Red Lion Road and Philmont Ave., Bethayres, Pa.

PURCHASES CAPITAL STOCK OF DOELCAM CORP.

▲ The outstanding capital stock of Doelcam Corp. has been purchased by Minneapolis-Honeywell Regulator Co.

Doelcam, which has a main plant and administrative offices in Boston and another plant and engineering laboratories in Newton, Mass., will be operated as a new division of Honeywell. There will be no change in the management.

Future Meetings

▲ Maintenance problems of steel mills will get special attention at the Plant Maintenance and Engineering Conference scheduled for the International Amphitheater in Chicago, Ill., Jan. 24-27. A number of the 37 conference sessions scheduled will be devoted to the particular problems of the steel industry.

Two roundtable sessions will be devoted exclusively to maintenance in steel mills. Another session of particular interest will be "Materials Handling Equipment Used in Maintenance."

▲ The annual spring meeting of the National Society of Professional Engineers will be held February 18-19 in the Hotel Charlotte in Charlotte, N. C.

At United States Plywood Corp.—

Rapid order filling in U. S. Plywood's Philadelphia, Pa. warehouse is helped by modern materials handling methods.

C&D Batteries for EXTRA work

United States Plywood Corporation, the world's largest plywood organization, manufactures a wide variety of plywoods and related products. To help handle the millions of pounds of material moving through its 73 warehouses from coast to coast, U. S. Plywood uses C&D Slyver-Clad* batteries as a major source of power for many of the industrial trucks in daily operation. For U. S. Plywood, like hundreds of other important American companies, has found it pays to power with C&D Slyver-Clad batteries.

C&D Slyver-Clad batteries are approved as standard equipment by all electric truck manufacturers. For further information, write for catalogs.

*T. M. Reg.

C&D BATTERIES, INC.
of Conshohocken, Pa.

Manufacturers of Industrial Batteries since 1906
SALES AND SERVICE OFFICES
IN PRINCIPAL CITIES FROM COAST TO COAST

Mecco SAFETY

"WEDGE-GRIP"

STEEL TYPE HOLDER

Fast TYPE CHANGE FEATURE

Ideal for use on marking jobs requiring interchangeable type, this unit features a patented Safety Snap for speed and ease in changing type. Made to order in any size, it is made of Mecco Safety Steel to prevent spalling and mushrooming.

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keep production up with

AIRE-RECTIFIERS

the original Split System

CRANE CAB CONDITIONER

for Crane Cabs and Pulpits

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NOW—ALLOY CHAIN REPAIR SERVICE

in PITTSBURGH and HAMMOND

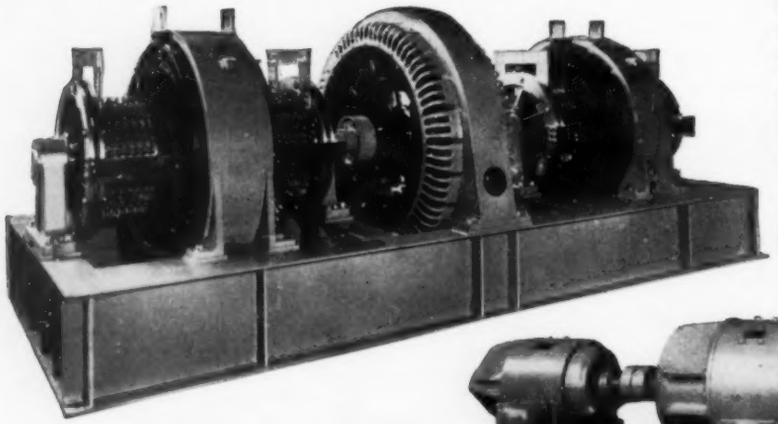
For greater safety and economy, have your Alloy Sling Chains returned to either our Pittsburgh or Hammond plant for repair, inspection and testing, at nominal cost.

S. G. TAYLOR CHAIN CO., Hammond, Ind. and 3505 Smallman St., Pittsburgh 1, Pa.

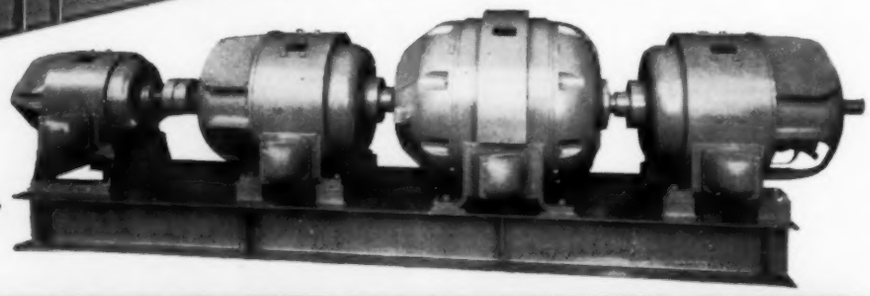
COLUMBIA

MOTOR GENERATORS

Whether it be for continuous electrolytic tin-plating or electrocleaning lines, or for special power needs, Columbia builds Motor Generator Sets for your individual requirements. They're giving superior, around-the-clock performance in many of the country's leading mills. Illustrated here are typical installations of Columbia generators built to specification.



Two 7500 Ampere 24 volt, 3750 Ampere 48 volt, Separately Excited, Columbia D.C. Generators driven by 600 HP, 1.OPF, 360 RPM Synchronous Motor.



Multi-Unit Columbia Motor Generator Set consisting of two 50 KW, 250 Volt, D. C. Generators, and one 10 KW, 50 Volt, 200 Ampere booster Generator, all driven by 200 HP, 0.8PF, 1200 RPM Synchronous Motor.

COLUMBIA ELECTRIC MFG. COMPANY

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MORGANIZATION... 3-dimensional airline under your plant roof

Reduce the congestion and costly delays of moving equipment and materials across the floors of your plant. Move loads of any weight swiftly through the air *above* men and machines with Morgan Cranes.

Morgan Cranes in capacities from 5 tons to the largest loads have been quality engineered since 1868. They incorporate the principles of Morganization... the design, engineering, building, and servicing of Morgan Cranes, Rolling Mills, and special heavy machinery to serve you years longer at lower annual maintenance cost.

Let us put Morgan Cranes and Morganization to work for you. Write to:

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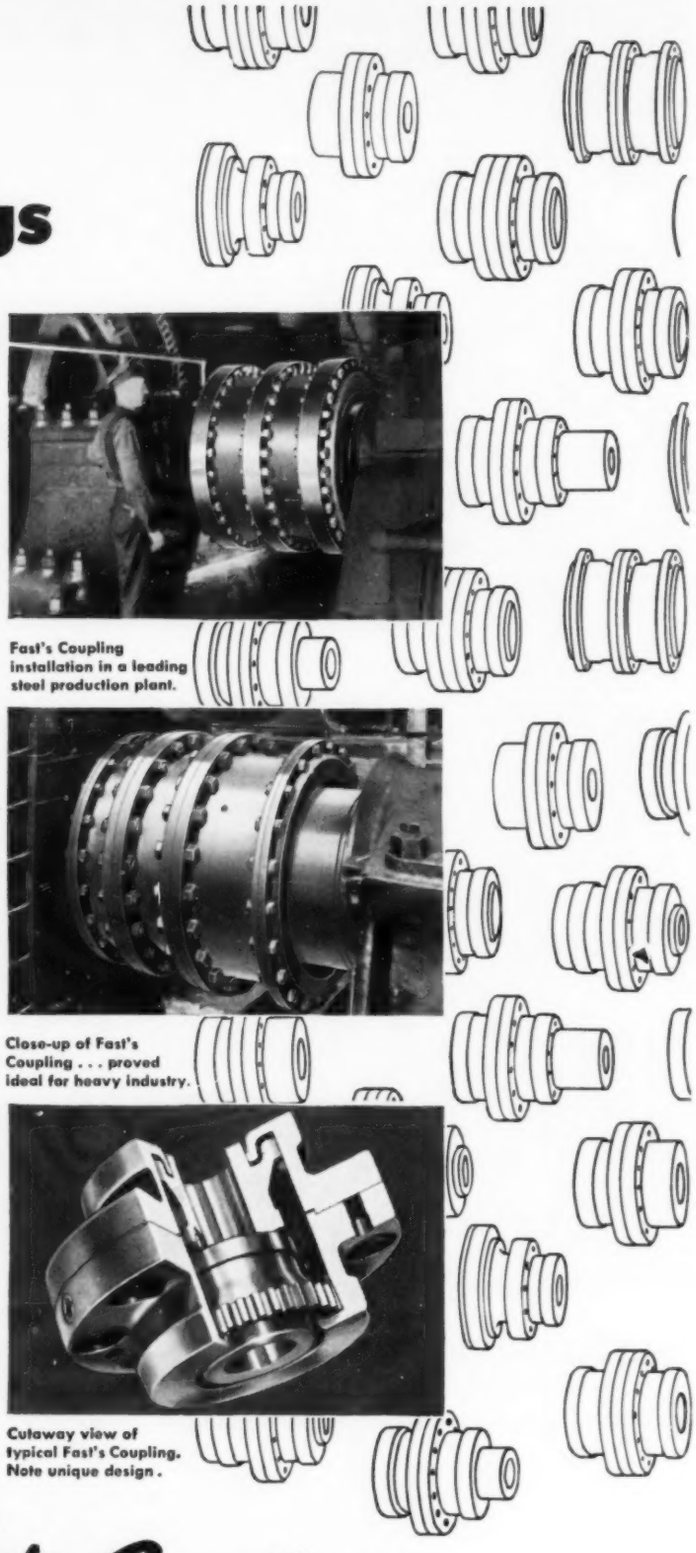
See why
FAST'S Couplings
are your wisest buy

LESS DOWN-TIME. Industry finds that Fast's Couplings, the original gear type coupling, give trouble-free performance. They save on maintenance. Save money (often thousands of dollars in production losses) year in, year out, because there is no down-time due to breakage . . . no expense of replacing perishable parts.

LOWEST COST PER YEAR because Fast's Couplings usually outlast the equipment they connect. Many Fast's Couplings are still in use after 30 years. Why? Because they are ruggedly constructed of the sturdiest, most practical materials . . . all steel in construction, unique in design.

FREE ENGINEERING SERVICE. The same "Know-how" that goes into the manufacture of famous Fast's Couplings . . . that has resulted in over three-fourths of a million successful installations . . . applies to its extensive engineering service. 35 years of experience in developing the most satisfactory materials and designs, means our staff is well prepared to give you the most effective and cost-saving solutions to your coupling problems. Just outline and send them to Koppers for assistance. And send for free catalog. Just mail the coupon below.



Fast's Coupling installation in a leading steel production plant.

Close-up of Fast's Coupling . . . proved ideal for heavy industry.

Cutaway view of typical Fast's Coupling. Note unique design.

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FAST'S Couplings

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METAL PRODUCTS DIVISION • KOPPERS COMPANY, INC. • BALTIMORE, MD. This Koppers Division also supplies industry with American Hammered Industrial Piston and Sealing Rings, Koppers Electrostatic Precipitators, Aeromaster Fans and Gas Apparatus.

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Gentlemen: Send me a Free, Fast's Catalog giving detailed descriptions, engineering drawings, capacity tables and photographs.

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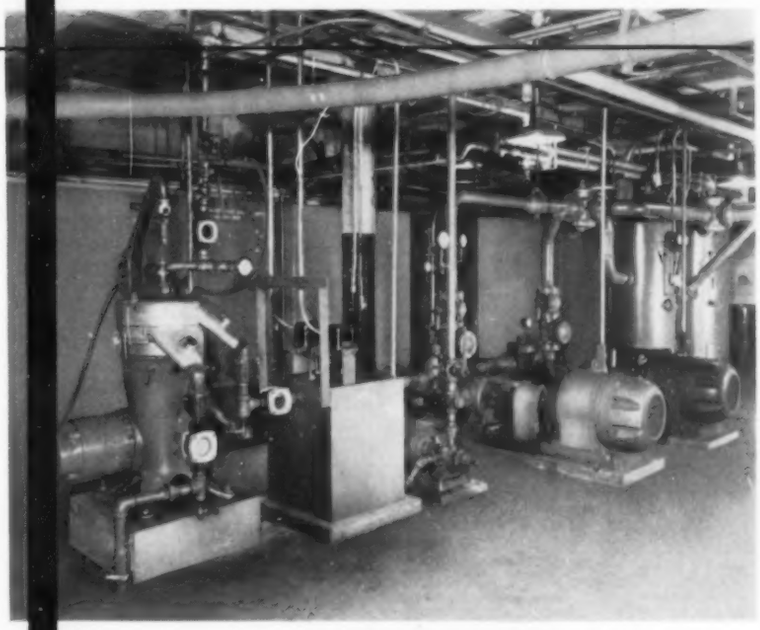
Equipping a New Mill?
Revamping an Old One?

MAKE THE PLANS PERFECT WITH A DE LAVAL DESIGNED LUBRICATING SYSTEM



De Laval *knows* mill lubrication . . . has custom engineered systems for many of the best known mills in the country.

By putting the responsibility in the hands of De Laval, these mills have made certain that the four fundamentals of efficient, economical lubrication will be provided.

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De Laval custom designs complete systems for large mills . . . provides self-contained De Laval Uni-Lube layouts for smaller ones. Write for complete information . . . now.

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TONNAGE

SUPERIOR "X" ROLLS
AJAX DUPLEX ROLLS
SPECIAL PROCESS ROLLS
SPECIAL TUBE MILL ROLLS
ATLAS, ATLAS "B" AND
ATLAS "X" ROLLS

BLAW-KNOX

LEWIS ROLLS

Blaw-Knox Company / Rolls Division
Lewis Rolls Department / Pittsburgh 1, Pennsylvania

Personnel News...

Paul E. Thomas has been appointed assistant chief engineer central operations — steel, of U. S. Steel Corp. He was formerly assistant general superintendent at the corporation's Gary Works. Mr. Thomas joined Carnegie-Illinois in 1936. From 1942 to 1944 he was assistant chief engineer, and later, acting chief engineer for Carnegie-Illinois during construction and operation of the Gary armor plate plant. In 1947 he was appointed assistant division superintendent of maintenance at Gary, and in 1948 he was named chief engineer. He was appointed assistant general superintendent of the Gary Works in 1950.

W. T. Adams has been appointed manager of purchases and raw materials of Republic Steel Corp., Cleveland, replacing **Fred J. Laskey** who has retired. **J. H. Graebing** and **L. H. Ransom** were made assistant managers of purchases. **Julius Olchen** was named purchasing agent of Republic's Truscon Steel Division in Youngstown.

C. E. Amos has been appointed administrative assistant to the vice president—production of Jones & Laughlin Steel Corp. He had been assistant to the general manager—ore mines & quarries since 1951. Mr. Amos came to J&L in 1937 as an industrial engineer at the Aliquippa Works. From 1946 to 1948 he was staff industrial engineer in the general office, Pittsburgh, and from 1948 to 1951 he was industrial engineer—raw materials.

J. Robert Ferguson, Jr., has been appointed chief engineer—project development, U. S. Steel Corp. He succeeds **Norman C. Michels** who was recently appointed assistant vice president in charge of engineering for the corporation's Tennessee Coal & Iron Division. Mr. Ferguson joined U. S. Steel in 1940. He was assigned to the Chicago District chief engineer's office and later Gary Steel Works. In December of 1942 he was transferred to Pittsburgh to work on coordinating Carnegie-Illinois' wartime expansion and maintenance program with requirements of War Production Board. In 1944 he was transferred to South Works in Chicago as assistant to works engineer. In 1947 he was made assistant chief engineer and assistant to the general superintendent in 1950. That same year he was transferred to New York where he worked on the development and engineering of the corporation's Orinoco project in Venezuela and he was transferred to Venezuela to assist in the construction work in November, 1952.

L. W. Moore has been appointed open hearth superintendent at the Steubenville Works of Wheeling Steel Corp. **G. P. Whitaker, Jr.** succeeds Mr. Moore as general foreman. Mr. Moore joined Wheeling Steel in 1953, coming from Crucible Steel Co. Mr. Whitaker has been with Wheeling Steel since 1948. He is a graduate of the company's practice engineering program, and prior to his recent promotion served as turn foreman in the open hearth department of the Steubenville Works.

Charles E. Moyer has been named superintendent of the open hearth department of the Buffalo District of Republic Steel Corp. He is succeeded as assistant superintendent of the open hearth department by **Donald A. Husband,** open hearth melter at the Buffalo plant since 1947. Mr. Moyer had been assistant superintendent since 1947.

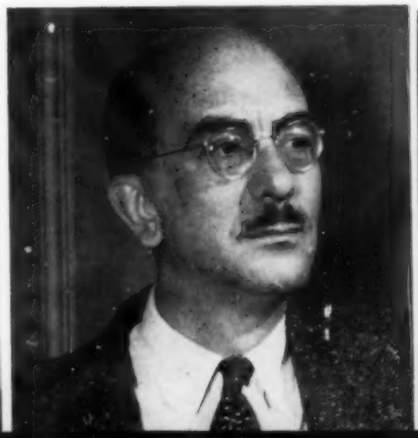
E. S. Steigner, a veteran of 20 years with the Youngstown Sheet and Tube Co., has been appointed supervisor of the company's newly organized service engineering department.

John V. Boardman, previously general superintendent of Green River Steel Corp. has been elected vice president in charge of operations.

Walter F. Klump, in charge of the Chicago district purchasing office for the Youngstown Sheet and Tube Co., will retire November 30, after 36 years of service. He will be succeeded by **Robert H. Kelly,** a veteran of 18 years in the company's purchasing department at Youngstown. He will have the title of assistant purchasing agent in charge of the Chicago purchasing office.

PAUL E. THOMAS

W. T. ADAMS



C. E. AMOS

J. ROBERT FERGUSON, JR.

R. S. POISTER

WALTER H. WIEWEL

LORIN L. FERRALL

PHILLIPS HAWKINS

R. S. Poister, former vice president of operations, Crucible Steel Co. of America, and **Walter H. Wiewel,** former vice president of sales, have been named senior vice presidents. In their new capacity, Mr. Poister and Mr. Wiewel will be relieved of daily routine in their particular fields so that they may devote their full capabilities to problems of over-all policy. Both Mr. Poister and Mr. Wiewel are directors of the company. **Lorin L. Ferrall,** previously assistant vice president of operations has been elected vice president of operations.

Phillips Hawkins has been appointed assistant to vice president—raw materials, U. S. Steel Corp.

Raymond W. Ball, formerly chief engineer of cranes at Morgan Engineering Co., has been appointed sales engineer for the Arnold Hughes Co., Detroit, Mich., representatives for Milwaukee Crane and Service Co.

I. H. Peak was appointed Philadelphia District Manager of the Electric Controller & Manufacturing Co. He succeeds **Henry K. Hardcastle,** who retired October 1 after 30 years in that capacity.

Dr. A. R. Powell, who has been associate manager of the central Research Department of Koppers Co., Inc., since 1949, has been named acting manager of that department following the resignation of **Dr. G. F. D'Alelio.**

Edward A. Alton was appointed manager of orders at Republic Steel Corp.'s Warren District steel plants. He succeeds **John E. Manley,** who is retiring after nearly 40 years with the company. **David A. McClelland** succeeds Mr. Alton as assistant manager of orders.

Herbert H. Meinert has been named sales representative of U. S. Graphite Co., for the Michigan territory.

John E. Haig, vice president and secretary of Ajax Electric Co., was elected president to succeed **William Adams, Jr.,** who died November 1. **Leon B. Rosseau,** was re-elected vice president, and **E. A. Ginkinger,** formerly treasurer, was elected secretary-treasurer.

J. Gordon Barker was elected president of Vanadium-Alloys Steel Canada Limited. **J. P. Gili,** president of the American parent company, Vanadium-Alloys Steel Co., who has been serving as Vanadium-Alloys Steel Canada president, now becomes chairman of the board for the Canadian affiliate.

Dr. Maurice J. Day, formerly associated with the Armour Research Foundation of the Illinois Institute of Technology, where he was assistant director in charge of program development, has been named director of research and development for Crucible Steel Co. of America. Dr. Day joined Carnegie-Illinois Steel Corp. at Gary, Ind. as a metallurgist in 1937. Later he served

DR. MAURICE J. DAY

with the same company as a technical trade representative in Chicago, Ill., from 1941 through 1945, and as manager of the Alloy Division there from 1945 to 1947. He served with the U. S. Steel Corp. as a physical chemist at its basic research laboratory in Kearny, N. J., from 1938 to 1941. In 1947, he was named assistant metallurgical engineer for alloy steels at the corporation's Pittsburgh offices. Dr. Day resigned from the corporation in 1952 to become manager, Materials and Processes Division, of the Armour Research Foundation. The next year, he was named assistant director for program development for the same organization. He held that position until his present Crucible appointment.

J. A. Ackermann has been appointed chief engineer of the Elwell-Parker Electric Co. He succeeds **J. C. Erickson** who resigned.

Wagner®
ELECTRIC MOTORS
... the choice of leaders in industry

SAVE maintenance dollars with Wagner Fan-Cooled Industrial Motors

HERE'S HOW—

the Wagner Cartridge Bearing Design cuts your maintenance costs:

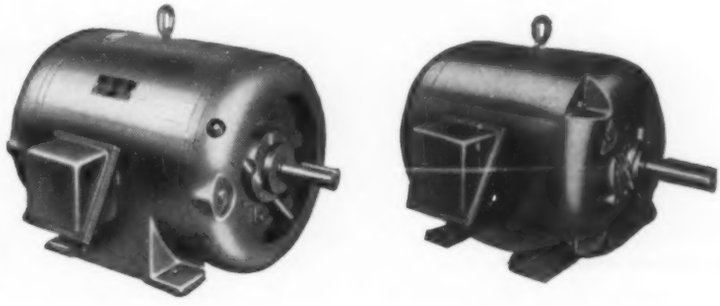
Bearings are protected at all times. The Wagner design completely encloses the bearings in a sealed cartridge. Labyrinth seals prevent the entrance of water, dirt and other foreign material. Even when the motor is disassembled, the cartridge remains intact as part of the rotor shaft. The bearing housing stays completely enclosed for full protection against dirt and dust.

Wagner Bearings can be relubricated. When lubrication is necessary to forestall premature bearing failure in unusually severe applications, readily accessible lubrication openings permit addition of grease or complete relubrication.

Wagner Bearings run longer between grease periods. Hot bearings shorten grease life. Wagner bearings have a low temperature rise because the design incorporates a deflector shield that directs a cooling stream of air around the bearing housing. Bearings run cooler and longer between maintenance periods.

This cartridge bearing design is a feature of the entire Wagner line of totally-enclosed fan-cooled motors. The line includes standard and explosion-proof steel frame motors, and standard and explosion-proof cast iron frame motors. All types are available with normal torque or high torque characteristics, in ratings to 250 hp.

For complete information—just call the nearest of our 32 branch offices, or write for Bulletins MU-132 and MU-196.



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ELECTRIC MOTORS
TRANSFORMERS
INDUSTRIAL BRAKES
AUTOMOTIVE BRAKE SYSTEMS—AIR AND HYDRAULIC

M54-16

Norman L. Danforth has been appointed manager of the Toledo district of Allis-Chalmers Manufacturing Co.'s general machinery division. He succeeds **W. W. Moore**, who died October 20.

Robert Potter, vice president and manager of the Salem, Ohio, division of the E. W. Bliss Co., will assume the office of assistant executive vice president on January 1, 1955. He will be located in the company's

ROBERT POTTER

general offices in Canton, Ohio, and will assist in the general supervision of the manufacturing divisions and subsidiaries. He is a former chief engineer of Superior Steel Corp., and came to Bliss as chief engineer of the rolling mill division shortly before being named division manager in 1946. **George Perrault, Jr.,** sales manager

GEORGE PERRAULT, JR.

of the rolling mill Division at Salem, will assume the duties of division manager of the Salem division. Prior to joining Bliss, Mr. Perrault joined the Salem Engineering Co. as an erection engineer and later became sales engineer and sales manager.

George W. Kessler has been appointed chief engineer of the Babcock & Wilcox Co.'s Boiler Division.

Hjalmar A. (Andy) Anderson was recently appointed chief project engineer of Lindberg Industrial Corp. He will be in charge of industrial furnace, special machine and production line equipment design.

Leslie Clifton Whitney, manager of development engineering of Copperweld Steel Co., Wire and Cable Division, has been elected president of the Wire Association.

Edwin Vereeke was promoted to the position of executive vice president of Heil Process Equipment Corp. Previously he had been vice president in charge of sales.

EDWIN VEREEKE

Jefferson C. Falkner has joined Copes-Vulcan Division, Continental Foundry & Machine Co. Mr. Falkner was formerly manager of electric production for Consolidated Edison Co. of N. Y. He will serve as an engineering and customer consultant in the development of new and improved equipment for modern steam power plants.

A. G. Gilbert has been named manager, standard products sales of Heyl & Patterson, Inc.

A. G. GILBERT

Harry Naismith has announced his retirement as vice president in the Freyn Department, Engineering and Construction Division of Koppers Co., Inc. He was associated for many years with the Open Hearth Combustion Co., which merged with the Freyn Engineering

THE *New Look* IN PICKLING LINE PINCH ROLLS

Youngstown Continuous Strip Pickling Line Complete with Latest Operating Features.

F&Y

PARALLOY

REGISTERED TRADE-MARK

Eliminate

Pick up
Scratching
Galling
Chatter Marks

the rolls with uniform hardness all through, which insures maximum tonnage from new to scrap diameter.

Pickle more tons between grinds with Paralloy rolls . . . Increase production and cut maintenance costs. Let our engineers quote on Paralloy pinch rolls—modernizing your present pickling line—or on a complete new pickling line.

The Youngstown Foundry & Machine Co.

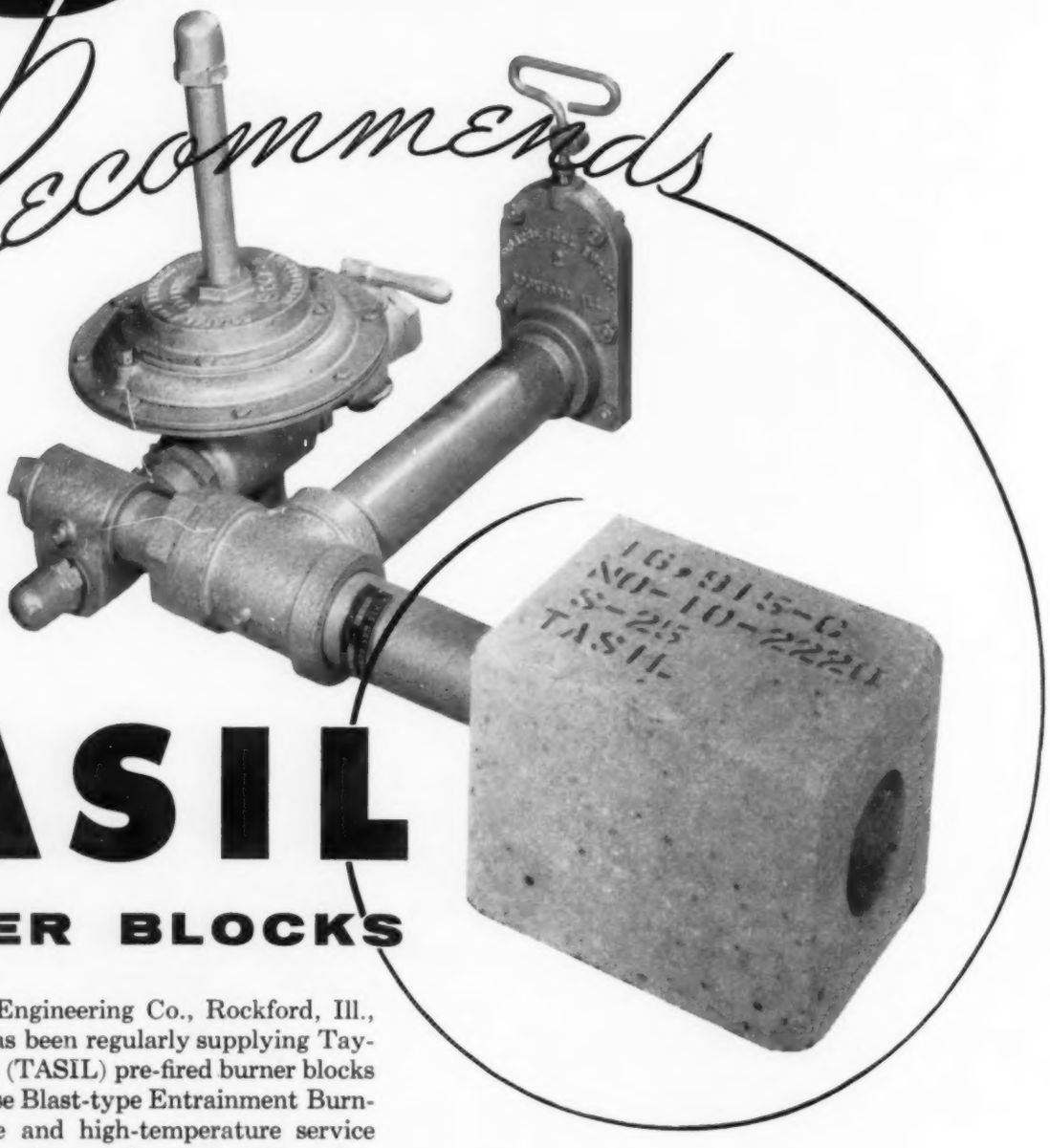
OVER SIXTY YEARS OF SERVICE TO THE STEEL INDUSTRY

Youngstown, Ohio

13

Eclipse FUEL ENGINEERING COMPANY

Recommends



TASIL

BURNER BLOCKS

Eclipse Fuel Engineering Co., Rockford, Ill., for 25 years has been regularly supplying Taylor Sillimanite (TASIL) pre-fired burner blocks on their Eclipse Blast-type Entrainment Burners for severe and high-temperature service in heating, forging, and metal-melting furnaces. TASIL is specified because these refractory blocks must give extended life and hold original dimensions without shrinking deforming, cracking or spalling.

TAMUL, the sintered synthetic mullite refractory, is also coming into wide use for high temperature applications. Like TASIL it has a softening point several hundred degrees above that of the best grades of fireclay, super-duty or silica brick; is unaffected by oxidizing or reducing atmospheres and is volume stable at operating temperatures of most industrial furnaces.

For longer service from your heating and heat-treating furnaces, specify TASIL or TAMUL burner blocks.

Exclusive Agents in Canada:
REFRACTORIES ENGINEERING AND SUPPLIES, LTD.
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TAYLOR ZIRCON TAYLOR SILLIMANITE

The CHAS. TAYLOR SONS Co.
A SUBSIDIARY OF NATIONAL LEAD COMPANY
REFRACTORIES SINCE 1864 • CINCINNATI • OHIO • U.S.A.

Co., prior to its merger with the Engineering and Construction Division of the Koppers Co. Mr. Naismith will continue to be available through the Koppers Co. on a consulting basis.

Robert J. Sahr was appointed to the newly-created position of vice president in charge of sales of Thermal Transfer Corp. Mr. Sahr has been a sales engineer since

ROBERT J. SAHR

joining Thermal Transfer Corp. in 1952. He formerly was metallurgical development engineer for the Silver Steel Co., Denver, Colo.

Grenville B. Ellis was appointed executive vice president of Nickel Cadmium Battery Corp., effective January 1, 1955.

Obituaries

Peter C. Rasmussen, superintendent of Republic Steel Corp.'s Moline, Ill., plant, died November 7. Mr. Rasmussen, 69, recently completed 50 years service in the steel industry. He had been superintendent of the Moline plant since 1918.

Mack C. Lake, 64, former president of U. S. Steel's Orinoco Mining Co., died November 9. Mr. Lake joined U. S. Steel in 1945. Exploration under his direction led to the discovery in 1947 of the iron ore deposits at Cerro Bolivar in the remote interior of Venezuela. Mr. Lake lived to see the completion of the Cerro Bolivar development and the shipment of Venezuelan ore to the steel mills of this country. In 1949, Mr. Lake was appointed president of the Orinoco Mining Co. when that U. S. Steel subsidiary was formed. He retired in January of this year, but he was retained by the corporation as a consultant on special assignments in the engineering and raw materials department.

Dr. Richard H. Patch, vice president—operations, of E. F. Houghton & Co., died November 13. Dr. Patch, who was 66, had been with Houghton since 1926.

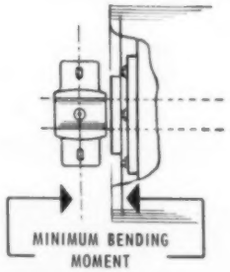
Take this step to insure pulley keyseat alignment

Link-Belt line includes welded steel and gray iron pulleys as well as welded steel slat pulleys. Choose from bolted or taper lock hubs.

Get LINK-BELT factory-assembled pulleys and shafts--take the work out of field mounting

IN addition to speeding field assembly and assuring alignment, Link-Belt factory-mounted pulleys have flush-hub design. The resulting minimum shaft deflection means better belt conveyor operation for you.

Whether your job calls for straight or crowned face . . . plain or herringbone vulcanized lagging —Link-Belt has popular sizes in stock. Call your nearby Link-Belt representative today for complete information.



Flush hubs minimize deflection, cut hub bolt stress and disc deflection.

LINK-BELT

13.430-A

WELDED STEEL CONVEYOR PULLEYS

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office: New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World.

CAPITALIZE

ON THE SPEED AND precision OF A FARREL® HD ROLL GRINDER

Faster and more accurate roll grinding means less cost per roll ground, plus a superior reconditioning of the roll.

You can capitalize on the use of a Farrel heavy duty roll grinder because this machine has the ability to consistently produce rolls with a flawless surface . . . straight or contoured precisely to specifications . . . *at a high output rate.* Design features also reduce setting-up time to a minimum.

Write for Bulletin No. 115 which gives full description of this cost-saving roll grinder.

The Farrel automatic crowning device produces a mathematically accurate curve for either convex or concave roll shape, without manipulation by the operator.

FB-910

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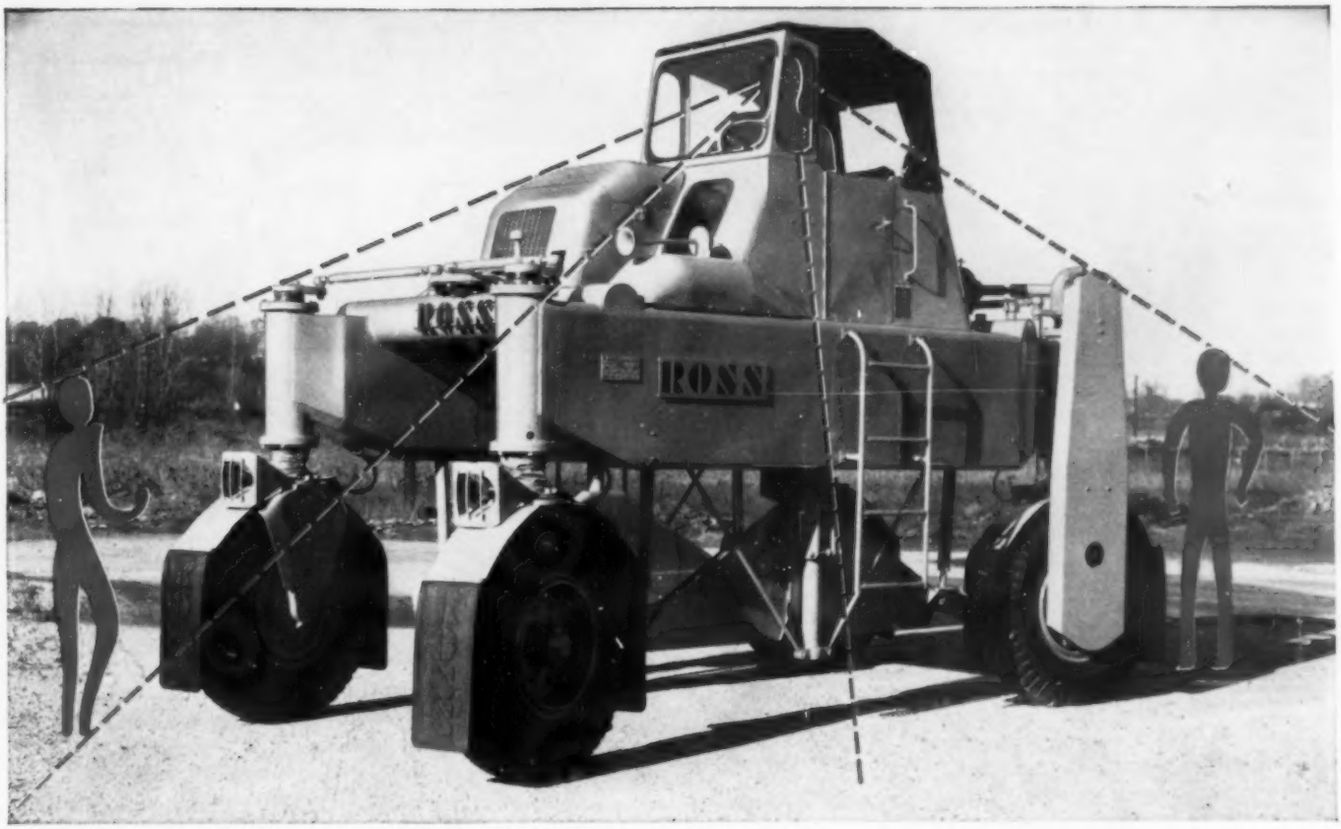

Meet the world's most modern 20,000 lb. carrier !

Advanced design of the Ross Series 81 Carrier means advanced efficiency and savings in its operation! The Series 81 is the one modern carrier in the middleweight class (20,000 lbs.)—we invite you to make your own comparisons to prove it to yourself. Here are some of the features:

RUGGEDNESS: tubular cross-members provide maximum rigidity; box-type double wall construction of side members is unsurpassed for strength and carrying capacity.

VISIBILITY: unequaled view of road and load!—driver can see 5-foot man 7 in. from front of carrier, 12 in. from right corner, 28 in. from right side. Load hook visibility is also excellent.

FASTER HOISTING SPEEDS: 35 ft. per minute.

ALL-HYDRAULIC OPERATION: load hooks, power steering, hook swing operate on totally enclosed hydraulic systems—require practically no maintenance.

CONCEALED SUSPENSION SYSTEM: springs in corner posts are protected from weather and abrasives; no Rocker arm to interfere with visibility.

With the Series 81, you can pick up a load faster and take off faster than with any competitive machine. For fast, horizontal transportation of 20,000 lb. loads, the Series 81 is by far your best buy. Contact your local Clark-Ross dealer (listed under "Trucks, Industrial" in the Yellow Pages), or send in the coupon for specifications.

CLARK® EQUIPMENT

ROSS CARRIER DIVISION
CLARK EQUIPMENT COMPANY
Benton Harbor 135, Michigan

Send specs on Series 81

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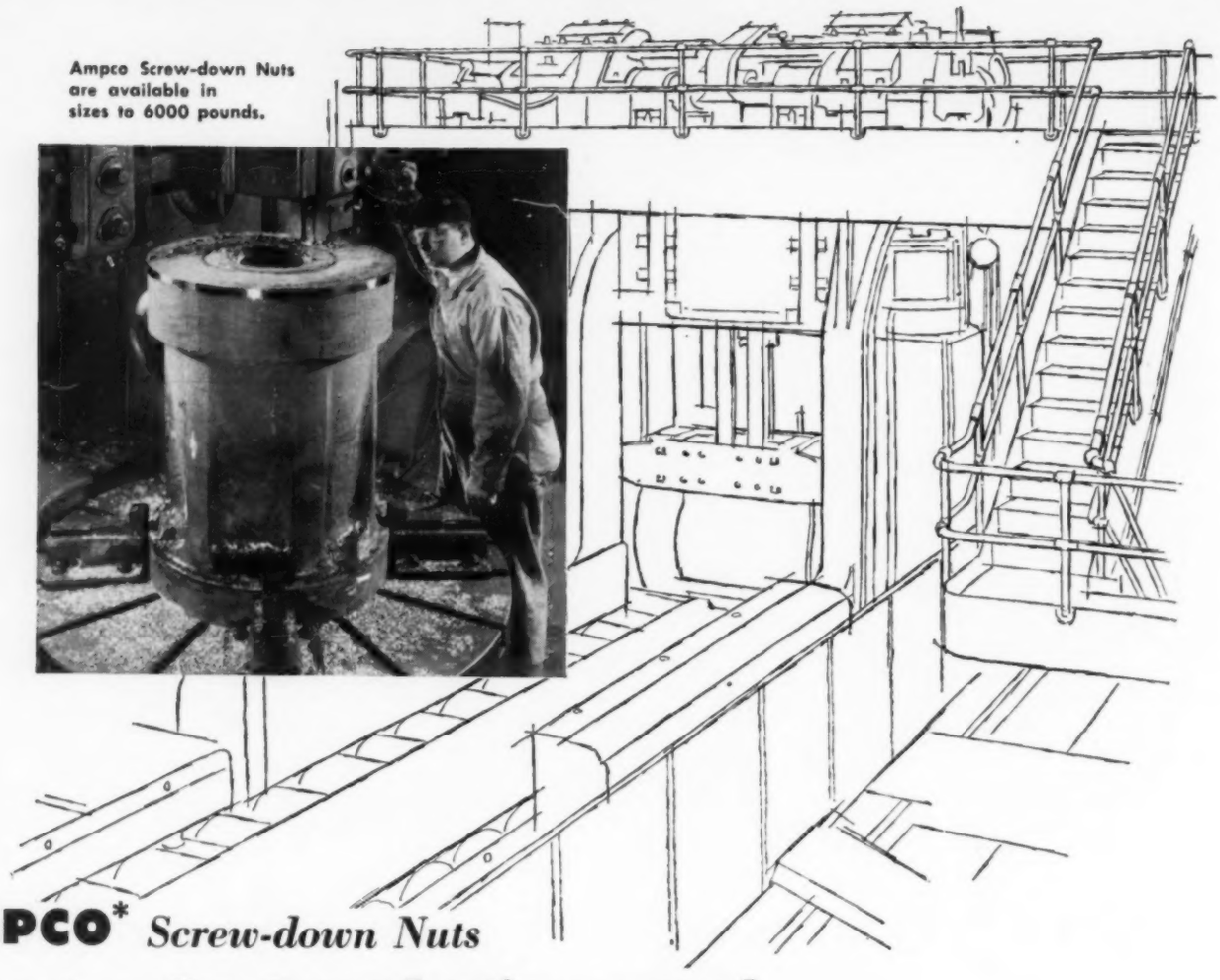
Ampco Screw-down Nuts are available in sizes to 6000 pounds.



AMPCO* *Screw-down Nuts*

help strip mill set production record

— handle extreme pressures to avert costly downtime and replacement

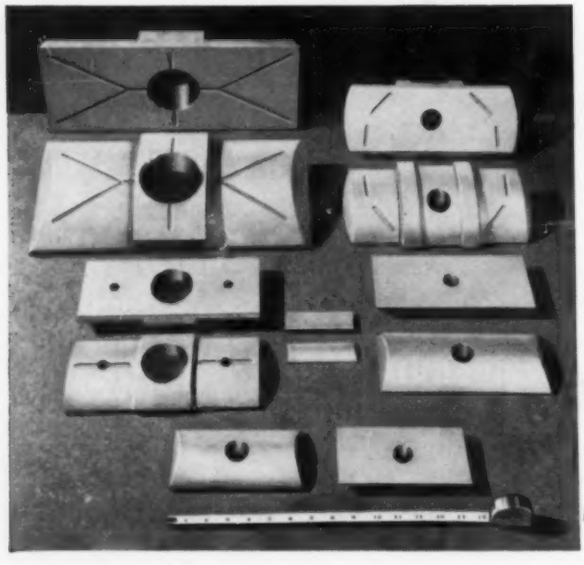
Here's where Ampco Metal's good bearing qualities, high compressive strength and ability to withstand tremendous impact and shock loads really pay off. Ampco Screw-down Nuts eliminate expensive adjustment and downtime . . . don't squash out. For example, one stand of an 80" hot strip mill using Ampco Nuts, utilizes 4500 hp at speeds up to 282 rpm. That means "king-size" stresses and strains. Yet the records show that in spite of normal screw-down pressures of between two and three million pounds, this mill produced over three million net tons of steel in 1953. Virtually no time was lost for screw-down nut replacement or adjustment.

Ampco Screw-down Nuts are centrifugally cast to insure sound structure and good wear resistance. They're available in sizes to 6000 pounds.

And Ampco slippers help keep mills running longer, too, because they have remarkable stamina . . . real resistance to wear and punishing shock loads. Mills that set production records depend on Ampco slippers to end frequent replacement — reduce spindle wear.

Slippers are available as rough castings or "cast-to-size" — minus 0, plus 1/32" or plus 0, minus 1/32". Oil grooves are cast in — if you want them.

Find out how these and other Ampco products provide real dollars and cents savings in *your* mill. Contact your nearest Ampco field engineer or write us direct.



Ampco Slippers available either as rough castings or "cast-to-size." Oil grooves can be cast in.

AMPCO®

Sole producer of genuine Ampco Metal

*Reg. U. S. Pat. Off.

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Ampco Metal, Inc.

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DECEMBER, 1954

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... any of the bulletins reviewed in the Publication Service of the IRON AND STEEL ENGINEER without obligation or cost. Simply circle the desired item numbers on one of the prepaid postal cards and mail. The requests will be forwarded to the manufacturers involved who will send the bulletins to you.

Note: Post cards expire three months after publication date.

(1) Maintenance

A series of pamphlets, designed as a handy reference for motor and generator maintenance, is available from National Carbon Co. Entitled "National Brush Digest," the pamphlets are specially edited for the operating man. Published bi-monthly the installments are concise, easy to read, and profusely illustrated, and should prove especially helpful to trainees. First mailing includes all back issues.

(2) Straddle Carrier Applications

Analysis of the implications contained in the trend toward straddle carriers are treated in a 16-page, two-color booklet just issued by the Clark Equipment Co., manufacturer of the Ross Carrier. The booklet uses the case-history approach documented by on-the-job photographs to describe carrier applications in 22 plants in ten industries.

(3) Control of Cooling Tower Water

A new four-page process data sheet, published by Leeds & Northrup Co., offers suggestions on measurement and control of the pH of cooling tower water, and describes equipment for this application.

(4) Controlling Oil Burners

An automatic and simple means of proportioning oil and air to industrial burners of the two-air connection type is described in a booklet issued by Hauck Manufacturing Co. (Bulletin 722.)

(5) Industrial Trucks

Pictured and described in a 12-page bulletin, published by the Yale & Towne Manufacturing Co., are gasoline, diesel and LPG industrial lift trucks in capacities ranging from 1,000 to 10,000 lb. Listed in this bulletin is a handy chart which provides a check sheet of specifications for comparing the different models of Yale gasoline powered equipment. (Bulletin 5101C.)

(6) Air and Electric Hoists

A full line of air and electric hoists for handling bulk materials of all types is described in a comprehensive catalog, available from Ingersoll-Rand Co. Outstanding features of each type and size are carefully outlined along with specifications, capacities, sizes, symbols and accessories available. Many applications in the general industrial field are illustrated as well as a variety of operations in the mining industry for which these heavy-duty units originally were designed. Cross sections of a number of hoists appear throughout the text. Single, double and triple construction hoists as well as drum lengths, frame construction and motor types are discussed and shown in line drawings as are scraper hoist symbols. Full descriptions of two types of remote control units, throttle equipment and several types of brakes, all for double or triple drum hoists, are accompanied by photographs and line drawings. Tables covering weights of materials and rope pull required for drawing cars up grades or inclined tracks are included in the useful information which accompanies suggestions for rolling friction allowances. (Form 5300-A.)

(7) Automatic Carbon Potential Control

A new technical bulletin describing the automatic carbon potential control system for automatic carbon control of heat treat furnace atmospheres has just been issued by Surface Combustion Corp. This new bulletin describes the means by which the carbon potential of the furnace atmosphere may be controlled at the desired level for such processes as case carburizing, homogeneous carburizing, carbon restoration and clean hardening. The methods discussed are applicable to continuous and batch type heat treat furnaces. (Bulletin SC-168.)

(8) Rubber-Insulated Cables

The Okonite Co. announces publication of a bulletin on Okolite-Okoprene 0 to 5000 volt unshielded, rubber-insulated, neoprene-sheathed cable. As this is the cable type most commonly used by industrial and utility plants for low voltage power and control circuits, the current carrying capacity tables, short circuit curves, voltage regulation formulas, and methods for determining conduit sizes, pulling tension and bending radii should prove extremely useful. Also, a thorough discussion on the advantages of cables that do not require shielding for 4160 volt operation is included. The bulletin is divided into four main sections: Construction features; engineering information; installation and handling techniques; splicing and terminating procedures. (OK-1085.)

(9) Magnesia Refractory

Basic Refractories, Inc., announces the availability of a new, illustrated brochure, entitled, "Ramset—New and Unusual Applications." The booklet discusses in limited detail new uses of this unique magnesia ramming mix, designed for original bottom construction and maintenance of open hearth and electric steel producing furnaces. Among the lesser known applications discussed are its uses for: rammed runners; short spouts and aprons; furnace construction; mold stools; and setting ladle nozzles. (Bulletin D-10¹.)

(10) Hydraulic Press Control

A new and unusual application for the Hagan ring balance meter—in the control of high pressure hydraulic presses of 2000 psi and upwards—is described in a new four-page bulletin issued by Hagan Corp. The bulletin reviews the successful experience of a large

forging shop in applying the meter to control the water level in high pressure bottle accumulator systems supplying storage for pumps used to operate the hydraulic presses. The ring balance meter, commonly used for all types of flow metering, in the new application measures the water level directly rather than using the air pressure method. Changes in water level cause rotation of the ring which in turn closes or opens mercury switches in a sequential operation, making automatic control of the pumps possible. Total pumping capacity for operation of all presses is cut approximately 50 per cent. (Bulletin MSA-109.)

(11) Silver Anniversary Report

A pictorial review of twenty-five years of service to some of the leading utility and industrial concerns has been issued by the Pennsylvania Transformer Co. Pictured and described throughout the booklet, are different types and sizes of transformers. Also included is an illustrated review of the historical happenings and news events within the past twenty-five years. (Bulletin No. 2554.)

(12) Two-Point Presses

A new catalog has just been completed, describing the new line of Steelweld two-point presses recently introduced by the Cleveland Crane & Engineering Co. The presses are of the straight-side, tie-rod type. Sizes listed range from 160 to 500 tons capacity. Areas of bolsters listed go from 48 x 42 in. to 132 x 60 in. (No. 2018).

(13) Plant Communication System

A 16-page booklet on planned plant communications systems has just been released. Six basic manufacturing problems are graphically illustrated and analyzed. The importance of the proper flow of current information for efficient production as well as management control is discussed. Schematic diagrams help clarify problems in inter-departmental communications. Communications systems for materials handling, production planning, quality control, sales order and maintenance control are described. Proved solutions for the dissemination of information are included with explanation of the use of TelAutograph Telescriber Systems. Work in process control, reduction of "down-time," accurate transmission of information between all operating units of office and plant are some of the studies presented in this booklet.

(14) Oil Burners

This bulletin on high velocity oil burners contains complete information including operating principles, applications, dimensions and output data. These burners are particularly well suited for use in furnaces, ovens and dryers, kilns and in numerous specialized applications such as ladle heating, skelp furnaces, pressurized air heaters, bell kilns and submerged combustion equipment. (Bulletin No. 107).

(15) Shell Thread Rolling Machine

A new, four-page bulletin published by the Waterbury Farrel Foundry and Machine Co. shows and describes the company's automatic, inclined shell thread rolling machine. The booklet illustrates the machine as it is normally used, connected to an eyelet machine, and explains how it automatically rolls the required thread on hollow metal parts produced by the eyelet machine. Another illustration shows the shell threader arranged for independent hopper feed. Samples of some of the work which can be produced on the machine are reproduced to show various types and sizes of threads. The bulletin discusses the use, construction, operation, drive and tooling of the machine and gives a complete table of specifications, including capacities, for two different sizes. (Circular No. 833-El-2).

(16) Transformers

A new 16-page engineering manual for power transformers has been published by R. E. Uptegraff Manufacturing Co. The manual provides detailed physical and electrical characteristics for liquid-filled, single and three phase transformers from 750 through 10,000 kva. Sections are included on standard accessories, performance data, dimensions and weight, base dimensions, terminal arrangements and optional accessories. (Bulletin No. 133).

(17) Crown Couplings

The De Laval Steam Turbine Co. has issued a new bulletin describing their line of crown couplings. Included is an illustration showing an exploded view of the coupling and a table containing data necessary to select the correct coupling for a given application. (Bulletin 2203).

(18) Screening Equipment

The Link-Belt Co.'s line of screening equipment for efficient removal of solids from water, sewage and industrial waste is described in a new 28-page book. It gives complete dimension and specification data for four types of coarse screens for removing large solids, and three types of fine screens (with screen cloth) for removal of small solids. Tables to determine the proper size unit for handling various capacities are given. Three types of fine screens are described: (a) the revolving drum type, which rotates on a horizontal axis with the flow entering the inside of the drum and passing through the screen cloth which covers the drum; (b) disc screen type, which is a wire cloth covered wheel rotating on a horizontal axis with the water flowing through the cloth parallel to the axis; and, (c) liquid vibrating screens with very fine mesh for use when a relatively dry product is required. The brochure contains over 30 photographs of screening installations and information about the application of this equipment to get efficient, low cost screening. (Book No. 2587).

(19) Tool Room Wheels

The Carborundum Co. has published a brochure which describes a complete new line of tool room wheels and lists hints for conservation of tools. Included is a handy tool room chart which spells out recommendations for grinding high speed tool and die steels.

(20) Starters

A folder published by The Electric Controller & Manufacturing Co. describes a new line of starters for 2200-5000 volt motors. The folder illustrates starters using the EC&M type ZHA 50,000 kva Air-Break Contactor. For circuits of higher fault capability, these starters are built with current-limiting power fuses, and in Valimitor style (volt-ampere-limitor) in which air-core reactors limit infinite kva to a finite value easily cleared by the 50,000 kva contactor. (Folder 1060).

(21) Furnace and Oven Controls

A condensed catalog and price list contains information on Brown instruments and Minneapolis-Honeywell controls applicable to indus-

trial furnace and oven equipment. The latest edition of this catalog has been expanded to 44 pages to include the latest developments in instruments and controls for industrial heating applications. (Catalog 54-1).

(22) Industrial Control

A 24-page booklet published by Westinghouse Electric Corp. describes the company's range of industrial control. The brochure covers control components, individual control and control systems. A section is devoted to a discussion of services offered by Westinghouse to carry out industrial control application.

(23) Selection Guide for Flexible Couplings

A new handy pocket size selection guide published by Ajax Flexible Coupling Co. contains technical data — ratings, drawings, specifications, service factors, plus information on the various uses of Ajax rubber-bronze bushed flexible couplings. (Bulletin 57)

(24) Refractory Castables

J. H. France Refractories Co. has issued two new single sheet bulletins on the company's complete line of refractory castables. The bulletins contain brief product descriptions as well as recommended applications for refractory castables sold under the trade name, Hydrecon 3000, 5, 186 and 186 Extra Strength. A special table is devoted to composite, detailed technical and ordering information on each specific castable product, with particular reference to recommended use limits, modulus of rupture, linear change and cold crushing strength.

(25) Cast Steel Sheaves

Farrell-Cheek Steel Co. has just released a four-page folder relative to its improved carbon and alloy cast steel sheaves. The folder also contains information regarding its complete wire rope fittings and accessories. (Catalog 22)

(26) Tandem Rod Mills

A new, eight-page booklet published by Waterbury Farrel Foundry & Machine Co. covers the company's line of tandem mills used for high speed reduction of non-ferrous and ferrous rod. The bulletin includes many illustrations showing various sizes of tandem rod mills plus work samples and a cross-sectional reduction sequence. The text discusses the advantages of reduction by rolling and describes the function and application of the Farrel mills. Details are given of WF design and construction features which are factors in reducing operating costs. The pay off unit, straighteners, coilers and cooling method are discussed, in addition to the mill operation itself. A tabularized chart gives capacities and other data on various sizes of tandem mills which the company has built. A partial list of wire mill equipment and other metal-working equipment built by Waterbury Farrel is also included. (Circular 729-R)

(27) Slitting Machine Operation

The Ohio Knife Co. offers the second edition of a booklet on slitting machine operation which is intended to be a basic guide for new operators. This 28-page manual covers descriptions of equipment, set-up procedures, care of equipment and many helpful hints culled from years of safe and practical experience with slitting and cutting operations. Numerous diagrams and photographs illustrate major points in the text.

(28) Speed Variator

The Cleveland Worm and Gear Co. has issued a bulletin on a new speed variator. This booklet pictures and describes the speed variator with all its patented design features. Listed in the brochure are the advantages of this new speed variator, adapted to American industry for ruggedness and dependability. (Bulletin K-100)

(29) Lubrication

A two-color, four-page folder published by Alpha Corp. lists all types of their molybdenum disulfide lubricant. The folder describes new concepts of extreme pressure or boundary lubrication in which solid lubricants perform a major function. The folder explains the participation of Molykote lubricants in this "fringe area" lubrication field. The eleven major types of Molykote are listed and described according to their ingredients, their working temperature ranges, and their method of application. There is also a discussion of ten industrial applications where the lubricant's margin of superiority can be expected to be large. (Bulletin 103)

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PUBLICATIONS CURRENTLY OFFERED by Iron and Steel Engineer Advertisers

ITEM	COMPANY	BULLETIN	DESCRIPTION
50	ALLIS-CHALMERS MANUFACTURING CO.	BOOKLET 11B6285B	New load center substation booklet.
51	AMERICAN AIR FILTER CO., INC.	BULLETIN 241	Multi-duty filters.
52	AMERICAN BRIDGE DIVISION, U. S. STEEL CORP.		Heroult electric melting furnaces.
53	AMERICAN WHEELABRATOR & EQUIPMENT CORP.	BULLETINS 894, 914	Descaling of steel strip and sheets.
54	ASKANIA REGULATOR CO.	BULLETIN 139	Combustion controls.
55	BEDFORD FOUNDRY & MACHINE CO., INC.		Crane catalog.
56	BRISTOL CO.	BOOKLET P1245	Bristol electronic Dynamaster.
57	BROOKS OIL CO.		Leadolene industrial lubricant.
58	CLARK CONTROLLER CO.	BULLETIN 102DM	New heavy-duty limit switch.
59	CLARK EQUIPMENT CO.		Series 81 specifications
60	CLEVELAND QUARRIES CO.	BULLETIN 15-B	Buckeye silica firestone.
61	CLEVELAND WORM AND GEAR CO.	CATALOG 400	Worm gears and speed reducers.
62	DE LAVAL STEAM TURBINE CO.		Pump Fax Bulletin and power-savings chart.
63	DIAMOND POWER SPECIALTY CORP.	BULLETIN 1136	Wired industrial television.
64	DREVER CO.	BULLETIN B-52	Ammonia dissociator.
65	ELECTRIC CONTROLLER & MANUFACTURING CO.	BULLETIN 942	Welded plate resistors.
66	ELECTRIC CONTROLLER & MANUFACTURING CO.	BULLETIN 900	All-welded lifting magnets.
67	ELLIOTT CO.		Elliott equipment for the steel industry.
68	ENTERPRISE CO.	BULLETIN 501	Roller conveyor units.
69	FARREL-BIRMINGHAM CO., INC.	BULLETIN 115	Heavy duty roll grinder.
70	FOXBORO CO.	DATA SHEET 330-12	Open hearth reversal controller.
71	GENERAL ELECTRIC CO.	BULLETIN GEA-4654C	DC armored motors.
72	GENERAL MOTORS CORP., HYATT BEARINGS DIVISION	CATALOG 150	Roller bearing catalog.
73	GULF OIL CORP.		Lubricants for reduction gear drives.
74	E. F. HOUGHTON & CO.		Acitrol pickling inhibitor.
75	JOHNS-MANVILLE	BOOKLET IN-115A	Insulating brick and fire brick.
76	JOHNS-MANVILLE	BROCHURE PK-462	Clipper seals.
77	KOPPERS CO., INC., FAST'S COUPLING DEPT.		Coupling catalog.
78	LINK-BELT CO.	BOOK 2416	Belt conveyor idlers.
79	MINNEAPOLIS-HONEYWELL REGULATOR CO.	DATA SHEET 4.3-4a	Fuel-air ratio controllers.
80	NATIONAL CARBON CO.		Maintenance digest.
81	OKONITE CO.	BULLETIN IS-1075	Rubber-insulated cable.
82	PITTSBURGH LECTROMELT FURNACE CORP.	BULLETIN 9	Lectromelt furnace bulletin.
83	ROSEDALE FOUNDRY & MACHINE CO.		Economies effected in roller guide applications.
84	RUST-OLEUM CORP.		Rust preventive literature and color chart.
85	SHARPLES CORP.	BULLETIN 1264	Oil purifiers
86	STEARNS MAGNETIC, INC.	BULLETIN 35-B-2	Lifting magnets.
87	SUN OIL CO.		Sunep extreme pressure oil.
88	TRABON ENGINEERING CORP.	FOLDER 5410	Machine tool lubrication.
89	UNITED STATES GRAPHITE CO.		Brush catalog.
90	WAGNER ELECTRIC CORP.	BULLETINS MU-132, MU-196	Fan-cooled industrial motors.

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1011 EMPIRE BUILDING

PITTSBURGH 22, PA.

hot strip and billet

Descaling...

the Aldrich way

Aldrich Spray Nozzles for knife-edged cutting water

Effective descaling may mean the difference between a quality product and one that is not. Whether used for hydraulic descaling of billets, sheets, plates, or small parts—*Aldrich Descaling Systems* insure quick, thorough results.

Aldrich Direct Flow Pumps supply the high water pressures that do the job. *Aldrich Spray Nozzles* produce the solid, compact, knife-like spray pattern that breaks up scale and carries it away. The impinging force is equal to 95% of the potential energy supplied to the nozzle orifice . . . high efficiency with less water, no excessive cooling here!

A replaceable disc arrangement insures ease of maintenance and simplicity of repair. Aldrich discs are made of hardened stainless steel, machine ground to uniform contour. Profiling and burnishing to a polished finish remove the slightest imperfection on the orifice. Every Aldrich disc is hydraulically tested for uniform pattern and force.

For Spray Nozzles—or complete Descaling Systems—call on Aldrich.

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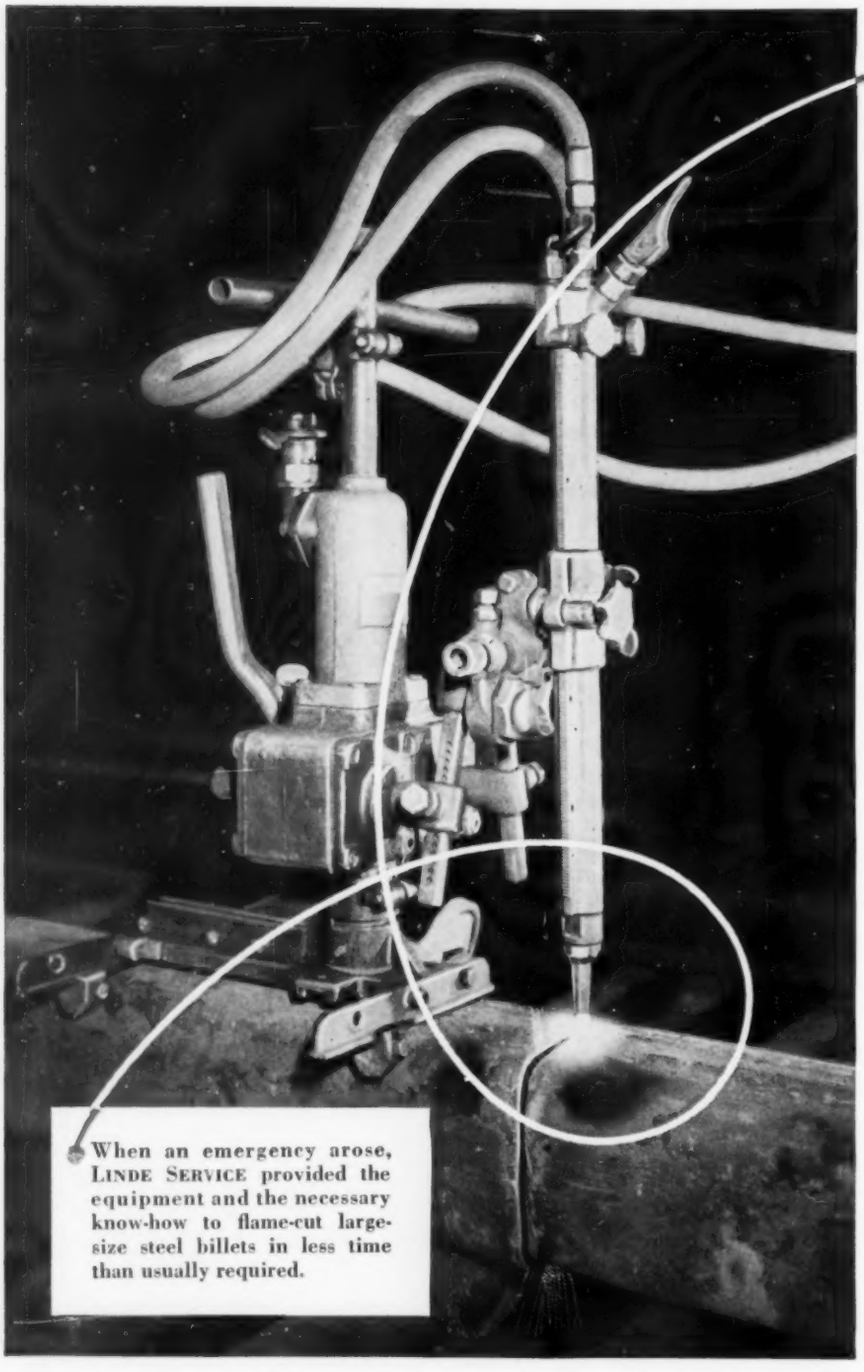
How LINDE SERVICE*...and Oxygen SOLVED THIS CUTTING PROBLEM



When an emergency arose, LINDE SERVICE provided the equipment and the necessary know-how to flame-cut large-size steel billets in less time than usually required.

When a hot saw broke in a Pennsylvania rolling mill, LINDE SERVICE was called in. LINDE engineers quickly set up four oxy-acetylene bar-cutting machines. Four hundred tons of 7⅝-inch alloy billets, each 40 feet long and each requiring four cuts, were handled at a temperature of 400 degrees. The whole job, including loading and unloading, took only seven hours. And half of the flame-cutting machines were manned by inexperienced operators!

The mill people were well pleased with the results—so much so, that they intend to use the same flame-cutting method every time a job like this comes up.

*LINDE SERVICE

is the unique combination of research, engineering, and more than 40 years of accumulated know-how that is helping LINDE customers save money and improve production in their uses of oxygen and oxy-acetylene processes.

If your company uses oxygen, LINDE SERVICE can mean dollar savings to you. Let us tell you more about it.

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A Division of UNION CARBIDE AND CARBON CORPORATION

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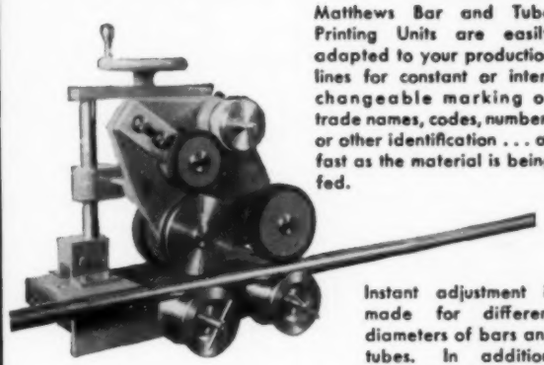
Linde Trade-Mark

BAR AND TUBE MARKING SIMPLIFIED



Matthews Bar and Tube Printing Units are easily adapted to your production lines for constant or interchangeable marking of trade names, codes, numbers or other identification . . . as fast as the material is being fed.

Instant adjustment is made for different diameters of bars and tubes. In addition, hand-held bar and tube markers are also available for limited production requirements.

Write Matthews today for complete information and literature. Include details of your bar and tube marking problems.

JAS. H. MATTHEWS & CO.
3962 FORBES ST. • PITTSBURGH 13, PA.
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FOR LONG-RANGE ECONOMY... SPECIFY...
PYLE-NATIONAL
ENCLOSED FLOODLIGHTS
WEATHER-TIGHT . . . DIRT-TIGHT

For permanent, outdoor lighting installations, Pyle-National floodlights are the most economical in the long run.

Rugged, corrosion-proof materials and tight gasket sealing against dirt and moisture keep maintenance and replacement costs exceptionally low. Pyle-National floodlights will retain their original high efficiency output indefinitely. Many installations are still in excellent operating condition after 25 years of service!

Write for catalog 2100, which gives a complete description of our extensive line of heavy duty floodlights. Sizes: 10"-12"-14"-16"-20"-23". Sold nationally through electrical distributors.

SINCE 1897

THE PYLE-NATIONAL COMPANY
1383 North Kostner Avenue • Chicago 51, Illinois

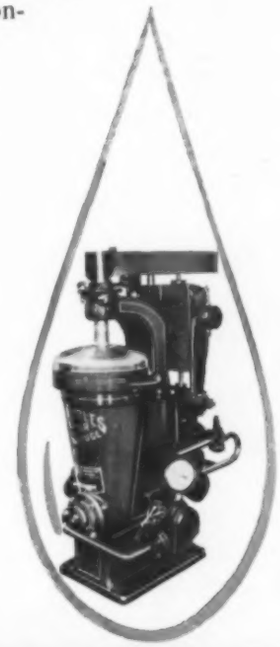
District Offices and Representatives in Principal Cities of the U.S. and Canada
PLUGS AND RECEPTACLES • PYLET CONDUIT FITTINGS

every DROP of LUBE OIL

. . . is a potential menace to bearings and other moving parts if it carries dirt, sludge and water.

That is why so many leading steel mills insist on Sharples Oil Purifiers in their lube oil systems.

With an absolute minimum of operating labor, a Sharples continuously removes impurities from the oil without removing additives, and without the expense and inconvenience of cartridges. With an absolute minimum investment you are assured of constant peak lubricating efficiency, greatly reduced oil make-up requirements, and less wear on capital equipment.



Get the facts about a Sharples —it will pay. Simply ask for Bulletin 1264.

SHARPLES
THE SHARPLES CORPORATION
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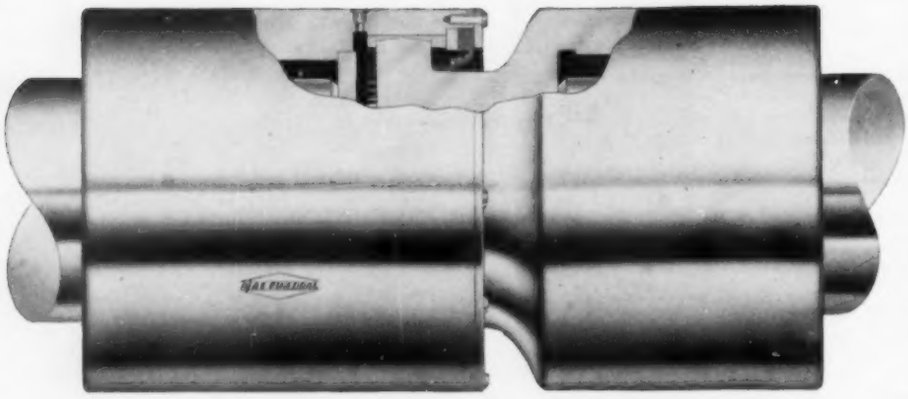
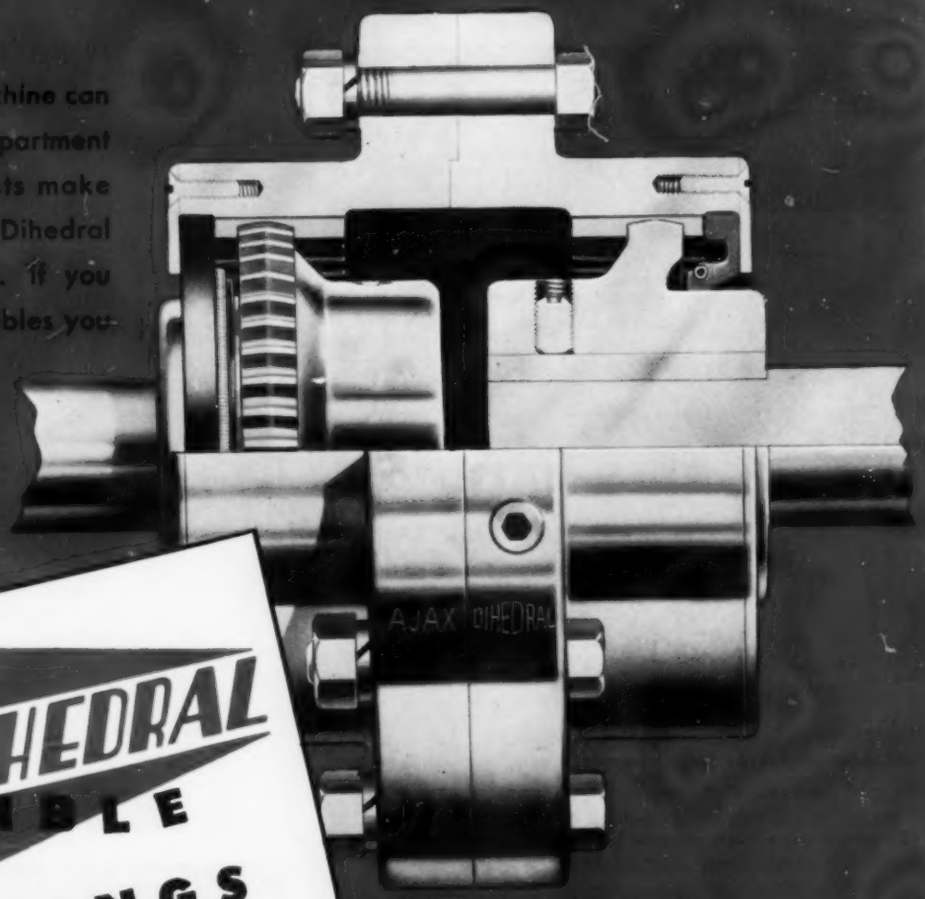
FIGURE YOUR COSTS, –*you will forget the price*



AJAX DIHEDRAL SPINDLE SHAFT COUPLING DESIGN is responsible for long life, trouble-free operation without the usual maintenance on spindle drives between pinion stands and rolls. Tell us your misalignment troubles.

Shutting down one machine can shut down an entire department or mill. Downtime costs make the extra price of Ajax Dihedral Couplings insignificant. If you have misalignment troubles you can't afford to be without Ajax Dihedral Couplings.

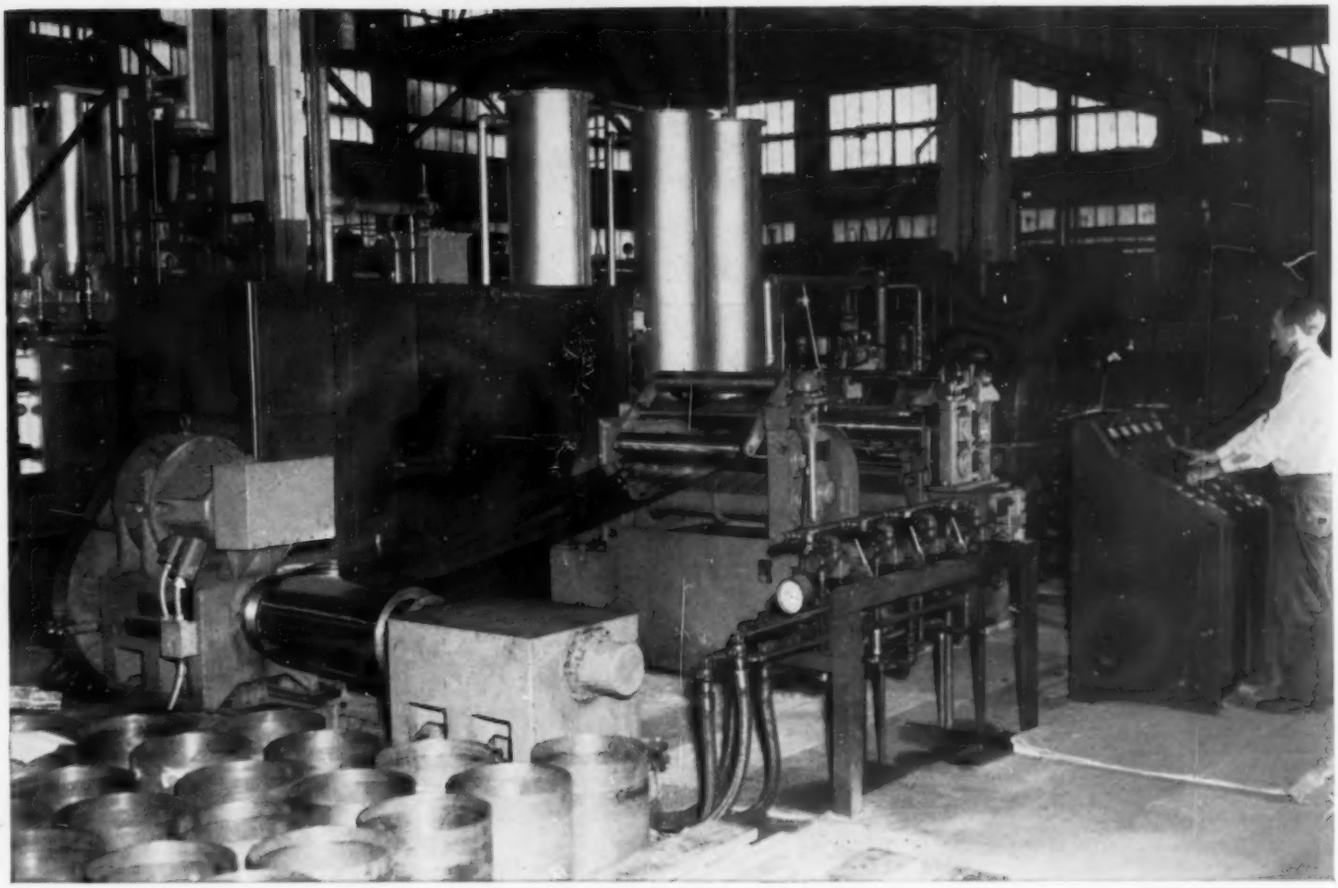


AJAX DIHEDRAL
FLEXIBLE
COUPLINGS

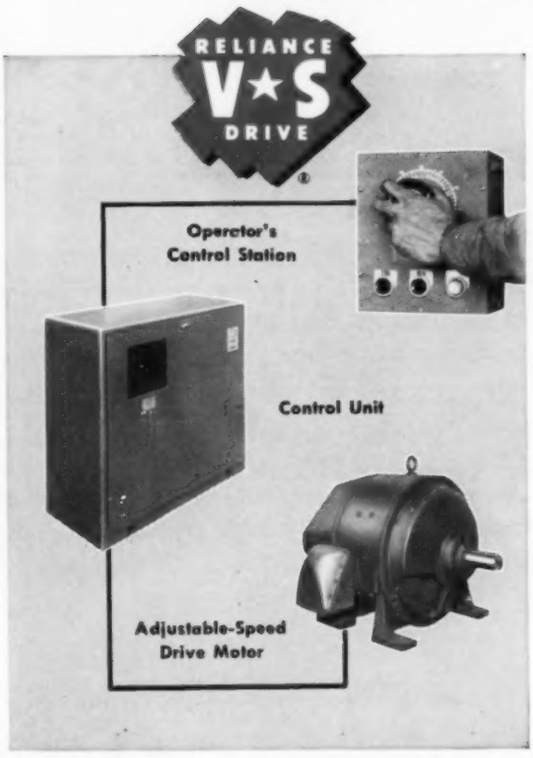
AJAX FLEXIBLE COUPLING CO. INC.

Representatives in Principal Cities

WESTFIELD, N. Y.



For Fast Production at Lowest Cost Use A Reliance V★S Drive



Throughout the steel industry, Reliance V★S Drives are providing the accurate controls necessary for cost-cutting, automatic operation of processing lines. In addition, these drives afford worthwhile savings of their own. For instance, they can be placed adjacent to process lines doing away with heavy cable runs from motor rooms to drive units. Factory-installed wiring between generating equipment and control units eliminates time-consuming field installation. Further savings are realized because every Reliance V★S Drive is tested at the factory, minimizing field checking and start-up time.

Reliance V★S Drives are available up to 300 hp. They are simple to operate and easy to maintain. And you can place them exactly where you want them.

We would like to tell you more about the savings these drives have to offer. Write and tell us when you would like to talk it over. D-1498

RELIANCE ELECTRIC AND ENGINEERING CO.

1084 Ivanhoe Road, Cleveland 10, Ohio • ***Sales Representatives in Principal Cities***

ALLEGHENY LUDLUM USES OKOLITE-OKOPRENE feeders for 70-ton arc furnaces

Cross section of 35 KV Okolite insulated power cable (⅔ actual size) which feeds arc furnaces at Allegheny Ludlum.

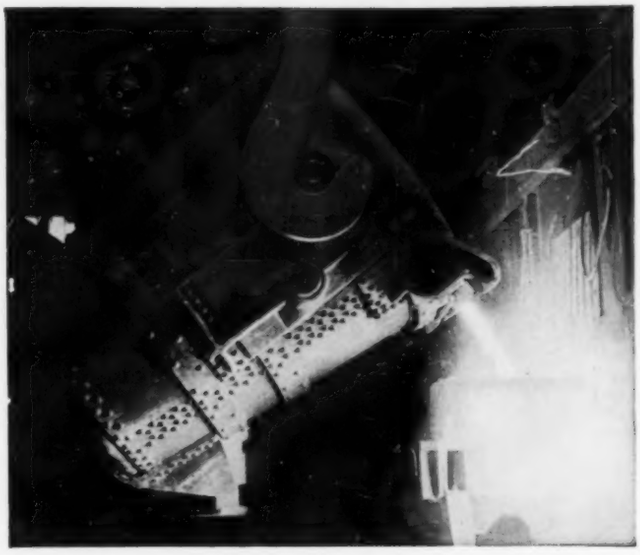
At the Brackenridge Plant of the Allegheny Ludlum Steel Corporation, two 70-ton and two 60-ton electric arc furnaces are equipped with Okolite-Okoprene rubber-insulated main power feeders. The cables are installed from overhead power feeders to the transformers and disconnect switches, and operate at 25,000 volts with peaks to 26,000 volts.

These single-conductor 750 MCM rubber-insulated cables with almost an inch (56/64″) Okolite rubber insulation and 8/64″ Okoprene sheath are rated at 35,000 volts, ungrounded. The installation at the Brackenridge Plant is another indication of the trend in industry toward the use of Okolite-Okoprene rubber-insulated cables for high voltage applications.

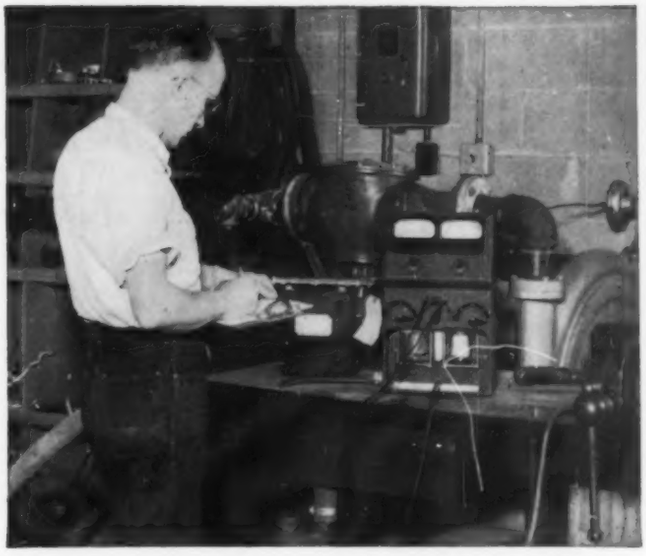
Okonite's new 128-page manual, Bulletin IS-1075, points out the advantages, versatility and economies obtained by the use of rubber-insulated cable for voltages up to 35,000 volts. Write for your copy to The Okonite Company, Passaic, New Jersey.

OKONITE OKONITE SINCE 1878 ***insulated cables***

2058



STEEL OUTPUT INCREASED BY 110 TONS PER DAY REPORTS STEEL PRODUCER: Tap-to-tap time reduced from 18 to 12 hours . . . Fuel cut 46% per ton produced . . . Tonnage up 50% daily! That's the job Cities Service Heat Prover helped perform for one of the largest steel producers.



"COMPLETED 30 HOUR TEST IN JUST 6 HOURS!" "We completed what normally would have been a 30 hour test in just 6 hours," writes the Eclipse Fuel Engineering Co. of Rockford, Ill. "We found the Heat Prover equally exact, perhaps more exact than standard commercial testing equipment."

INDUSTRY REPORTS ON FURNACE OPERATION:

PRODUCTION UP, COSTS DOWN WITH CITIES SERVICE HEAT PROVER

THE CITIES SERVICE HEAT PROVER . . . Not an instrument that you buy . . . but a service we supply . . . FREE!

Shown above are just two of the many outstanding accounts of the Heat Prover's impressive accomplishments. Wherever a furnace operation is involved, the Heat Prover can help increase productivity by providing:

- **Rapid, continuous sampling**
- **Simultaneous reading of oxygen and combustibles**
- **Direct measurement of oxygen and combustibles**
- **Easy portability**
- **Free maintenance and re-calibration service**

Learn how the Heat Prover, supplied and maintained free by Cities Service, can benefit you. For details, contact your nearest Cities Service office or write: Cities Service Oil Company, Sixty Wall Tower, New York City 5, N.Y.

CITIES SERVICE
QUALITY PETROLEUM PRODUCTS

Photo courtesy Bullard Machine Tool Co.

Photo courtesy Cross Co.

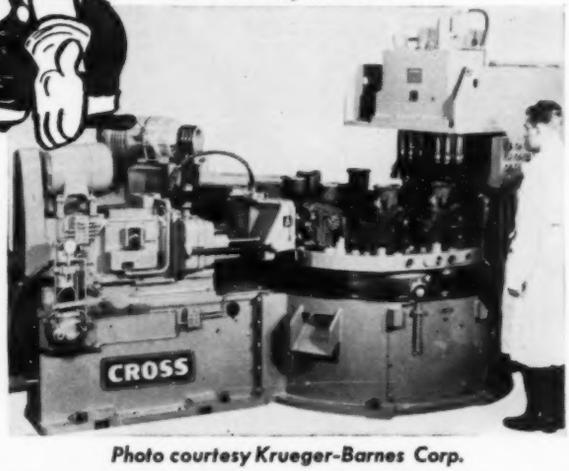
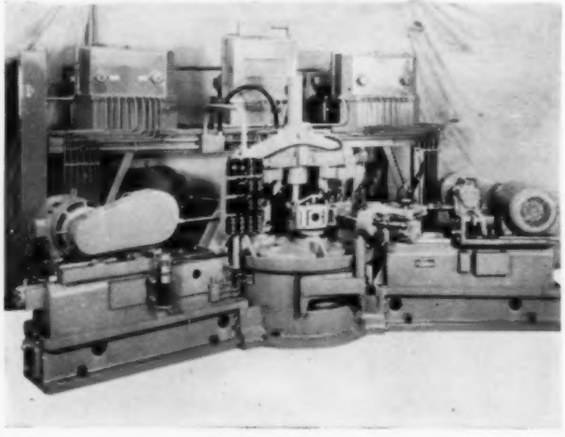


Photo courtesy Krueger-Barnes Corp.



TRABON automatic lubrication systems on machine tools assure *positive* lubrication while operating under full load.

Machine tool builders and operators know a Trabon system guarantees each bearing just the right amount of oil or grease at the proper time. It's impossible to skip a bearing since the operation of each measuring valve depends on the previous valve having operated first. A single indicator at the pump tells when each bearing has been lubricated.

Complete sealing enables Trabon systems to operate unaffected by harmful elements or severe operating conditions. The lubricant flows in a fully protected circuit.

Thousands of installations on machine tools are an important part of Trabon's quarter century of experience in providing trouble-free lubrication.

NEW *automatic* lubricant pumps have been developed to operate from hydraulic and pneumatic circuits. Also, mechanical types operated by cam action. Sturdy, compact, with adjustable discharge volume.

Write for our machine tool folder No. 5410

Trabon ENGINEERING CORPORATION

1814 E. 40th STREET • CLEVELAND 3, OHIO

Oil and Grease Systems

Equipment News...

BRAKING CONTROLLER

▲ Available from Westinghouse Electric Corp. is a compact d-c braking controller, no larger than a combination linestarter. The controller will provide braking torques of as much as eight times full load running torque, and is available in two sizes of enclosures for braking standard induction motors from 24 to 25 hp.

Operated from a single "start-stop" pushbutton, the new controller requires no adjustment after initial installation. Its main components are a selenium rectifier, contactors, transformer, and a timing circuit.

D-c braking, which consists of applying direct current to one phase of an induction motor after the a-c voltage has been removed, has these inherent advantages over mechanical braking: faster, more accurate stopping, no mechanical maintenance required; eliminates need for a double-shaft motor; solenoid hum eliminated. In addition, d-c braking has these advantages over other types of electrical braking: braking torque decreases rapidly as speed approaches zero, providing smoother, more accurate stops; motor cannot reverse; motor losses are relatively low; no external motor resistance required.

CONDITIONING UNIT

▲ Surface conditioning can eliminate imperfections extending about one-quarter of an in. into ingot surfaces, according to Vacuum Specialties, Inc.

An electric arc plays on the rotating ingot so that the entire surface is progressively melted in a helical path. The operation is carried out in a water-cooled furnace chamber under inert atmosphere or vacuum, and is entirely automatic.

Surface conditioned ingots are remarkably smooth and completely free of surface imperfections. The process is particularly applicable to valuable or accountable metals and alloys. Highly reactive metals can be processed, since the equipment is built to high vacuum standards of very low inleakage of air.

The equipment is custom designed and built for specific user requirements. Ingot sizes up to 16 in. x 48 in. are within the capabilities of present design.

COMBUSTION CONTROL

▲ Introduced by the Foxboro Co. is a compact, fully automatic combustion control system. With particular application in soaking pits, annealing and reheating furnaces, the system makes optimum use of blast furnace gas, as available, ratioing it with coke oven gas to provide a mixed gas with the necessary Btu content.

The system uses only three main instruments. A furnace temperature controller varies the quantity of fuel to the burners in accordance with changes in furnace temperature. A coke oven gas flow controller and a blast furnace gas flow controller together constitute a fuel ratio system which correctly blends the two gases so that the desired Btu input can be maintained. Any loss or other reduction in quantity of blast furnace gas is automatically compensated by an increase in coke oven gas. Thus, the system makes maximum use of economical blast furnace gas, but still provides sufficient Btu's to meet furnace requirements.

The system has flexibility in that the operator can manually adjust the separate feed flows or switch to automatic control, as desired. In addition, he can readjust the automatic fuel ratioing mechanism as changing combustion conditions may require.

D-C MOTORS

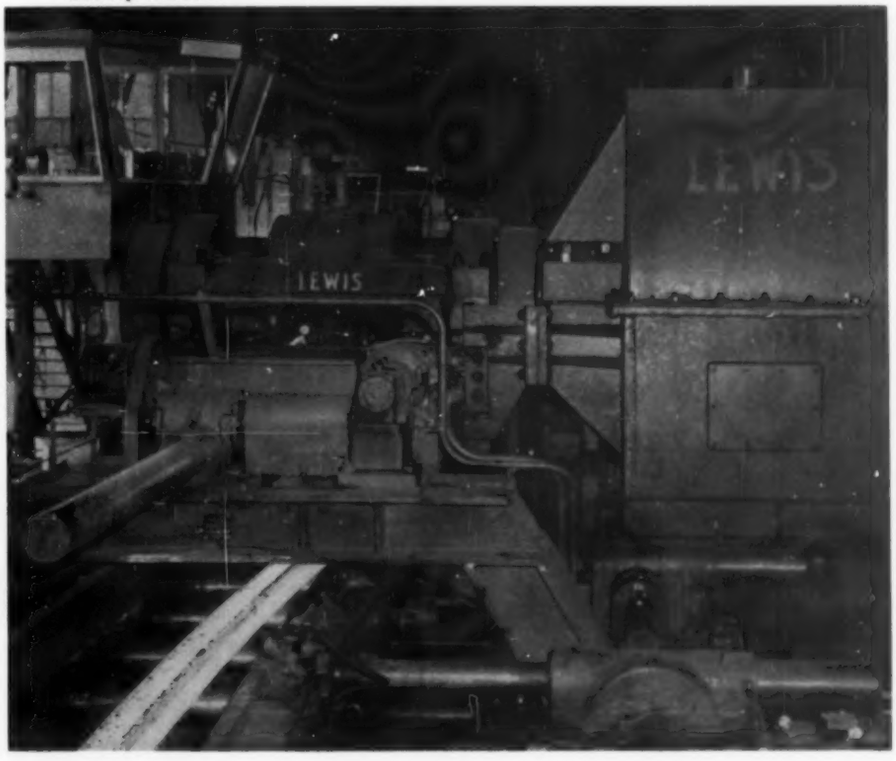
▲ Reliance Electric and Engineering Co. announces a complete new line of industrial direct-current motors.

The controlled reaction of motors to the demand for a change with a "Dynamic Response" formerly found only in specially designed machines is the everyday standard of performance of the new Reliance Super 'T' Motors.

These new motors are described as producing the fastest and most accurate response ever offered in a standard design motor, and are re-

SHEAR ADDED TO CLAIRTON BLOOMING MILL

Latest addition to the 40-in. blooming mill facilities at Clairton Works, U. S. Steel Corp., is this new mechanical motor driven shear, designed to cut hot steel slabs up to seven in. thick and 42 in. wide. Designed by Lewis Machinery Division, Blaw-Knox Co., the shear weighs 400,000 lb, has a maximum knife pressure of 2,200,000 lb, and a 13-in. combined up-and-down stroke. It will make up to 12 cuts per minute and is powered by a 250 hp motor.



HOUGHTON

ACITROL

PICKLING INHIBITOR

says *Yes* to all!

Readily soluble even without pre-mixing? *Yes!*
Effective at full range of bath temperatures? *Yes!*
Equally efficient for low or high carbon or alloy steels? *Yes!*
For all rolled or forged forms? *Yes!*
Resists breakdown at boiling point? *Yes!*
Maintains its stability in acid storage tanks? *Yes!*
Saves both steel and acid? *Yes!*
Prevents pitting and smut formations? *Yes!*
Leaves metal surfaces with bright finish? *Yes!*
Costs less per ton of steel? *Yes!*
Types available for either foam-forming or non-foaming? *Yes!*

Get latest ACITROL Bulletin. Ask the Houghton Man, or write
E. F. Houghton & Co., 303 W. Lehigh Avenue, Philadelphia 33, Pa.

ACITROL . . . a product of

E F HOUGHTON & CO.
PHILADELPHIA · CHICAGO · DETROIT · SAN FRANCISCO

Ready to give you on-the-job service . . .

ported to be twice as effective in many applications as any other motor now produced.

Here is an example of this new concept of Dynamic Response. A special 250 hp drive in a steel mill operates a flying shear, traveling at 2200 fpm into 81-ft lengths—within one-half in. accuracy. The drive was a special design; for each cut, the motor is accelerated to a precise speed, stopped, and repositioned in 1.7 seconds. Once requiring a highly-specialized design, this job now can be done with a standard Super 'T' Motor.

The motors are being produced in the sizes from 20 to 100 hp and the range will be extended both upward and downward to higher and lower horsepower. A complete range of mechanical enclosures has been developed to assure complete protection under every conceivable operating condition.

SOLDERLESS LUGS

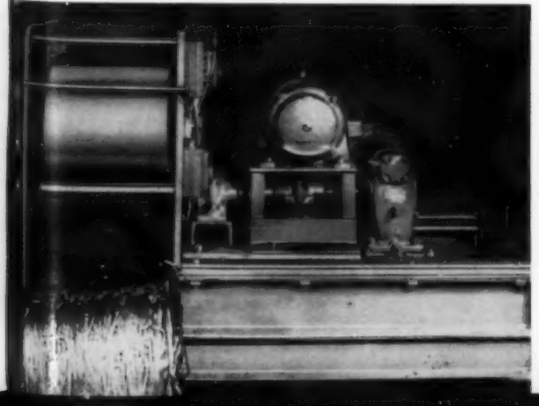
▲ Placed on the market by Ilsco Corp., are VT and LO two-hole collar solderless lugs in six sizes from 14 to 1000 MCM wire ranges.

Both lugs are produced from 100 per cent pure electrolytic copper for utmost efficiency. They offer double secure mountings where close spacing must be maintained and where connectors must not turn and come into contact with each other. VT and LO are advanced in mechanical design, compact, shockproof and cool in operation.

SCRAP BALLER

▲ Phillips Corp. has developed a compact, portable scrap baller that converts side trimmings on slitting lines into tightly packed bundles of No. 1 heavy melting scrap.

The new scrap handler can be used either as an independent unit or integrated on a slitting line. Several of the new machines have been installed in mills in Pittsburgh and Cleveland.



The unit occupies approximately four ft by seven ft of floor space and does not require a floor anchor. It is powered by a two-speed, five-hp motor which operates the mandrel at speeds of 25 or 50 rpm. It also is used for balling wire scrap.

On a slitting line, the mandrel pulls side trimmings into the machine and an oscillating roller keeps the scrap ball compact until it reaches a maximum diameter of 28 in. when the machine is automatically shut off by a micro-switch.

A hydraulic device withdraws the mandrel from the center and the ball rolls down an inclined plane to the floor for removal to scrap storage by lift truck.

Weight of the ball varies from 200 to 700 lb dependent on the type and size of the scrap and how well it winds on the mandrel.

DIRECT FLOW PUMP

▲ A pump which promises marked advantages and economies in a wide variety of industrial applications has been developed by the Aldrich Pump Co.

Called "Powr-Pac," this new unit is a 2½ in. stroke, 25 hp, direct flow Triplex pump. Designed to provide industry with a serviceable pump at lower cost, this newest addition to the Aldrich line embraces the direct flow fluid-end principle and all the well-known Aldrich construction features.

Because of its relatively small size, "Powr-Pac" offers economics to users who previously have been forced to buy pumps larger than actually needed.

One outstanding feature is the sectionalized fluid-end design. Individual fluid-end sections are easily replaced at a fraction of the cost of the entire fluid-end. Working barrel can be furnished in carbon steel, aluminum bronze, stainless steel or Hastealloy. Plungers are made of heat-treated carbon steel, stainless steel, solid porcelain or bronze. Valve seats are available in aluminum bronze, stainless or hard faced steel, and valves are available in aluminum bronze, Insurok, stainless steel or nylon.

The pump is precision-machined throughout. Crankshaft is of high

ENTERPRISE
ROLLER CONVEYORS
ARE MODERN INDUSTRY'S
ANSWER TO CONVEYING PROBLEMS

ROLLER CONVEYOR
ON DISPLAY
1954
IRON & STEEL EXP.
BOOTH 310 - ARENA

24 IN. "V" ROLL PIPE
CONVEYOR (DRIVEN UNIT)

These rugged individual conveyor units replace many conventional run-out tables and eliminate the need for mitre gearing, long shafting and interconnecting structure. Standard roll designs include V-Rolls, Flat Rolls, Tapered Rolls, Serrated Rolls and Water Cooled Rolls for furnace applications. Various face widths are available. Idler rolls can be furnished for installation between driven units.

For complete detailed information write for Bulletin 501

ESTABLISHED 1870
THE ENTERPRISE COMPANY
MACHINERY BUILDERS & ENGINEERS
SUBSIDIARY OF WM. K. STAMETS COMPANY · PITTSBURGH
COLUMBIANA 1, OHIO · U. S. A.

grade carbon steel; the frame is a semi-steel casting with power-end moving parts totally enclosed; and connecting rods are drop forged, with babbit-lined precision crank-pin bearings.

SAFETY SWITCHES

▲ A new and improved line of Type D (NEMA Type G) safety switches, in 30, 60, 100, 200, 400 and 600 amp capacities is announced by Federal Pacific Electric Co.

The 30 ampere line of type D safety switches has been redesigned. In addition, styling of enclosures is smart, modern, and uniform throughout the line.

Noark Type D switches feature solderless lugs and feed-through neutral for quick installation. Ample gutter space is provided for ease in wiring. Visible knife blades insure safety, and all live parts are completely recessed to eliminate the danger of accidental contact.

Dual blade construction and fewer joints assure cool operation and trouble-free service. All moving parts and contacts are readily visible for inspection and maintenance.

Switches are available in uniformly styled raintight enclosures with mounting ears that facilitate installation on posts and irregular surfaces. An indestructible metal nameplate containing complete switch data is mounted on the cover of every switch.

LUBRICANT

▲ A new type extreme pressure lubricant has been announced by the Pressure Products Co. Known as Spray-Lube it makes it possible to spray a superior, heavy duty lubricant on open gears, open chains, valve stems, etc., without preheating and then applying with brush or paddle.

Spray-Lube can be used in temperatures too high for normal grease or oil, and will not drip or throw off running gears. Excellent adhering qualities make it a good rust preventative.

The company says the lubricant reduces waste, eliminates mess, can be carried in a pocket, and makes possible lubrication of parts a brush or paddle cannot reach.

TRANSFORMER

▲ General Electric Co. announces a new vault-type network transformer with a radiator that is designed for strength and ease of cleaning and repainting.

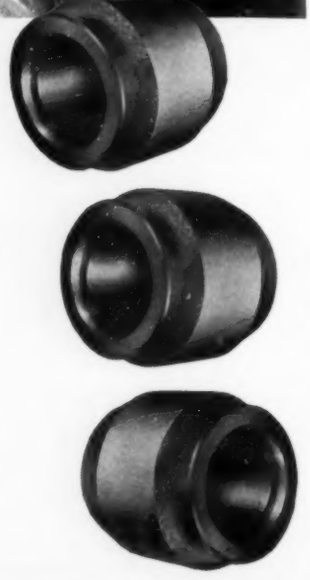
The new design incorporates tank bracing with tubular radiation, the box-like tank brace also serving as a manifold connector for the radiator tubes. The box structure stiffens the tank wall and facilitates cleaning and repainting by leaving free space between the tank and tubes.

Corrosive problems are reduced considerably in the new design because the dirt collecting surfaces have been practically eliminated.

Reliability of the transformer is improved and the chance of leaks is minimized because welds are easier to make and because fewer welds are needed than on conventional transformers. For example, on the new 500-kva unit, there are only 16 openings for tubes in the tank structure instead of 56, the number formerly required.

The new design is now available in all network transformer ratings.

MEEHANITE® ROLLER TWIST GUIDES
Cast by Rosedale Provide
1. LONGER SERVICE LIFE
2. LOWER INITIAL AND MAINTENANCE COSTS
3. REDUCED DOWN TIME



TYPICAL of the Meehanite castings made by Rosedale Foundry and Machine Company to solve "tough" problems for the steel industry are the roller guides shown in operation above.

On billet and bar these rollers have set tonnage records ranging from 60 to 70,000 tons per pair. Their initial cost is a fraction of the materials which they have replaced. Maintenance costs and down time are at a minimum since these tonnages are being obtained without re-grinding or re-surfacing.

For further information on Meehanite roller guides, write for a copy of "Economies Effected in Roller Guide Applications". Specialists in the field of supplying castings to the steel industry, our Engineering Staff is available to help solve all your casting problems.

ROSEDALE FOUNDRY & MACHINE CO.

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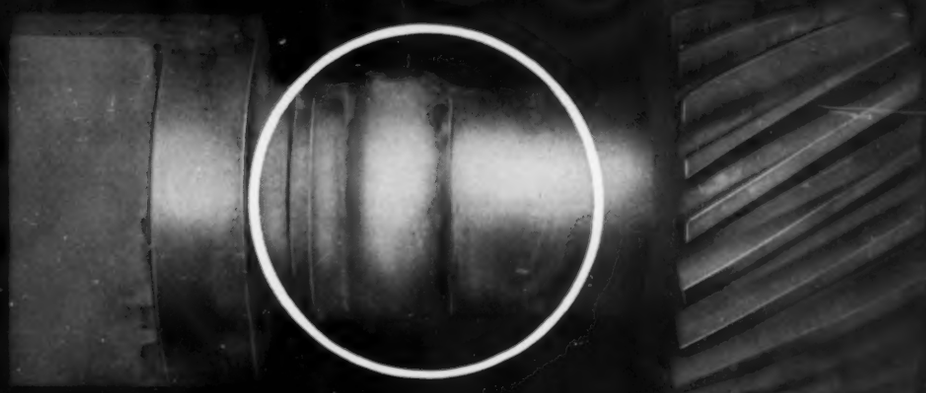
Here's where

THERMIT WELDING STOPPED THE CLOCK!



Weeks of idle time saved in returning pinion to duty...

When a piece of vital equipment breaks down, Thermit Welding stops the clock on idle time — enables quick, economical repairs on a variety of parts. Only a *minimum* of technical skill is required.

See the time-saving repair made on the 48" mill pinion shown above. The 28" neck was Thermit welded — and the pinion was back in operation *weeks* before a replacement could be obtained.

WAITING FOR REPLACEMENT PARTS COSTS TIME AND MONEY!

USE THERMIT WELDING

ALWAYS READY TO WORK FOR YOU

METAL & THERMIT CORPORATION

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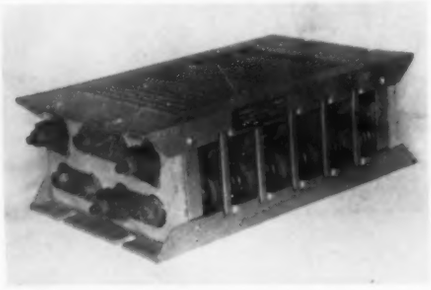
GUYAN
RESISTORS

Engineered and designed to eliminate resistor maintenance on troublesome mill applications.

Non-breakable helical coil construction ends burnouts due to warping and buckling of grids.

Sturdy, rugged steel construction eliminates shock and vibration troubles.

Custom designed for your conditions including excessive graphite accumulations.



With a quarter century of resistor engineering, we invite you to take advantage of our experience.

For complete information on Guyan Resistors, please contact the nearby Guyan Representative or our main plant at Logan, W. Va.

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Birmingham, Ala.—Ebbert & Kirkman Co., 2313 6th Ave. So.

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Detroit, Mich.—Plant Equipment Co., General Motors Bldg.

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Book Reviews . . .

"Verhutten von Eisenerzen," (Reduction of Iron Ores), by Robert Durrer, second edition, 159 pages, 6¼ in. by 9 in., 44 illustrations, four tables, was published in 1954 by Verlag Stahleisen, Dusseldorf, price 18.50 German Marks. This book is a critical comparison of experimental and industrial methods of reducing iron and steel from ores. Subjects covered are raw materials, electrical energy, metallurgy, including the influences of other elements, and descriptions and comparisons of processes for producing metallic iron either as a solid (sponge iron), in pasty form or as a liquid. Attention is paid to the use of electrical energy for bringing the materials up to reaction temperature.

The advantages and the shortcomings of the present-day tall blast furnace are discussed in detail. However, the use of high top-pressure is not mentioned. The effects of oxygen-enriched blast are explained (low-shaft furnace). The reduction of fine iron ore that had been mixed with finely crushed coal and then briquetted are described. Other methods discussed in the book are reduction in a rotating drum, and reduction on a flat hearth.

The author is not optimistic about an early replacement of the tall blast furnace by other methods and equipment. In his opinion, the blast furnace will reign supreme, until shortage of proper raw materials will compel metallurgists to adopt other methods of reduction. The book is not only a comparison of present methods, but also gives a glimpse into the future. A bibliography is appended. (Reviewed by W. W. Trinks).

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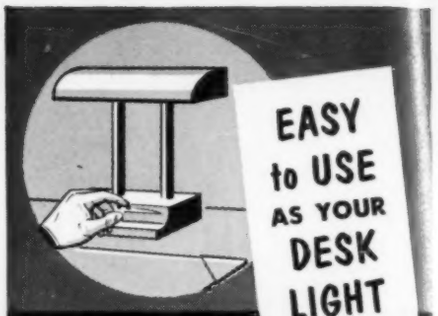

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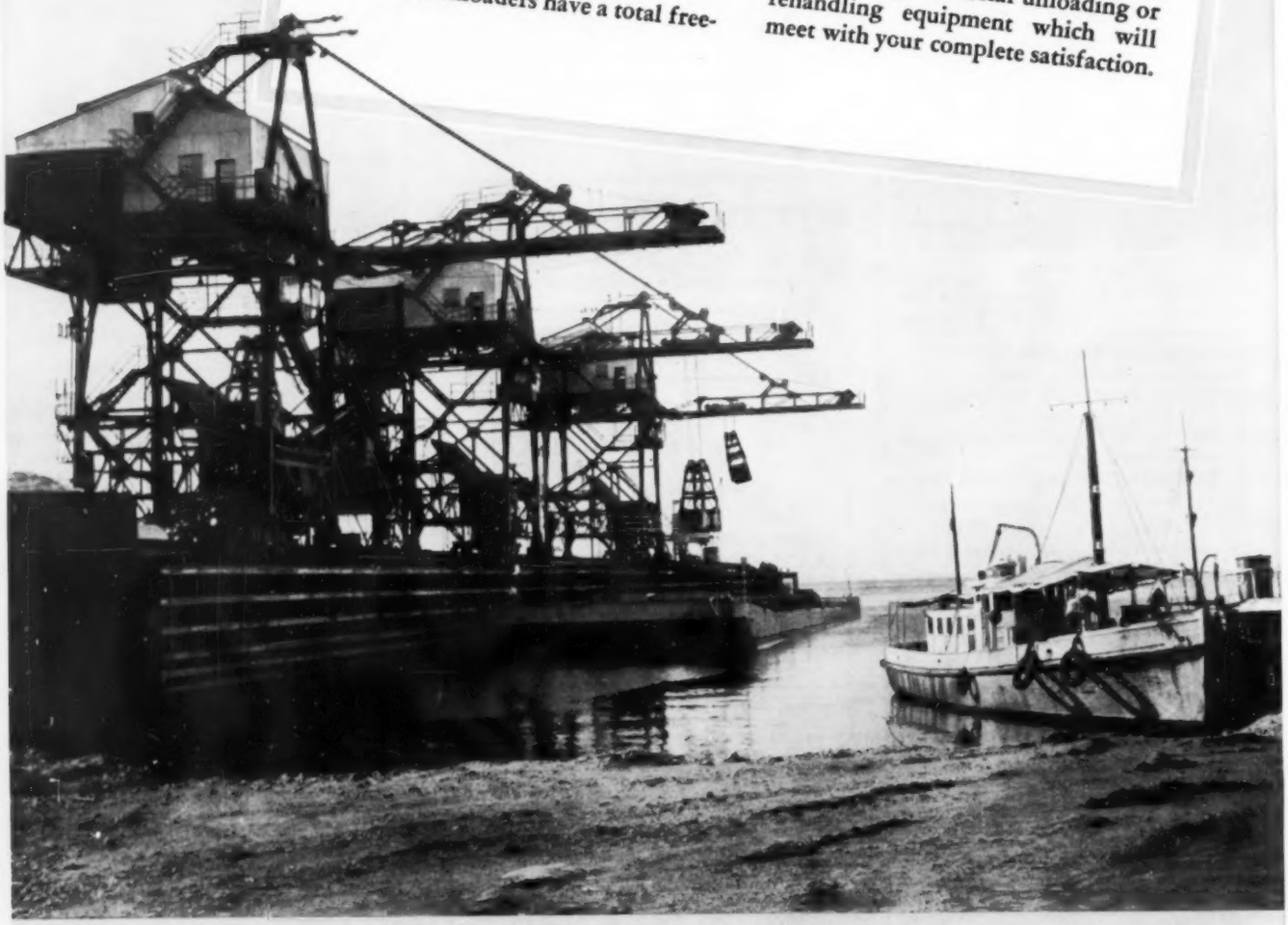

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IRON AND STEEL ENGINEER INDEX FOR 1954

Herewith is presented the index of all authors and papers published in the IRON AND STEEL ENGINEER for the year 1954

LIST OF AUTHORS

A

ALLISON, F. H., JR. and PETERSON, C. E. — "Modern Manufacture and Use of Cast Rolling Mill Rolls," December, 1954, Page 68.

APPERSON, J. S. — "System Engineering for Continuous Strip Processing Lines," June, 1954, Page 68.

ARMSTRONG, ELDON L. — "Factors Affecting Performance of High Temperature Greases," September, 1954, Page 167.

AARONS, J. S. and WARREN, R. G. — "Pumpability of Steel Mill Greases — Parts I and II," October, 1954, Page 67.

B

BAILEY, E. T. W. — "New Open Hearth Furnaces at Stelco," June, 1954, Page 91.

BARNS, B. D. and RAAFLAUB, H. E. — "New Soaking Pit Facilities at Steel Division of Ford Motor Co.," May, 1954, Page 109.

BEAMAN, P. A. — "Processing and Drawing of Steel Wire," October, 1954, Page 96.

BEARD, G. G. — The Economics of Replacement in the Steel Industry," October, 1954, Page 55.

BERRY, R. L. — "Applications for Laminated Fabric Bearings," September, 1954, Page 161.

BLACK, W. A. — "Uses of Resistance Wire Type Strain Gages in Steel Plants," November, 1954, Page 57.

BONETTI, JUAN M., MAVIS, FREDERIC T. and PECK, CHARLES F., JR. — "Temperature Stresses in Iron Work Rolls," June, 1954, Page 45.

BRADBURY, T. G. — "Metallurgical Aspects of Plant Maintenance," September, 1954, Page 90.

BRANDT, ALLEN D. — "Air Pollution Control in the Bethlehem Steel Co.," August, 1954, Page 103.

BRANDT, C. C. and SCAROLA, PHILIP — "Combination Bar and Rod Mill — Los Angeles Plant," July, 1954, Page 72.

BRITT, B. L. — "Transformer Maintenance," September, 1954, Page 101.

BRONLUND, L. R. and GRAHAM, D. C. — "Transformer Materials," August, 1954, Page 118.

BROWNING, E. H. — "Modern Arc Furnace Equipment and Practices," March, 1954, Page 71.

BURDEN, C. H. and ZELLEY, W. E. — "Increasing Rod Production by Conversion of a 2-Strand Rod Mill to 3-Strand Operation," December, 1954, Page 55.

C

CAMPBELL, G. J. — "Use of High Velocity Burners for Edge Heating Skelp," October, 1954, Page 111.

CARDWELL, GILBERT P. — "Modern Methods of Communication at Lukens Steel Co.," November, 1954, Page 127.

CARTER, GLENN O. — "Use of Oxygen in Steel Mills," June, 1954, Page 80.

CARTER, W. B. — "Daily Maintenance Cost Control — the Foreman's Tool," September, 1954, Page 123.

CLARK, M. S., KEISER, A. C., JR., PERSO, E. E. and MANDY, W. H. — "Steel Mill Lubrication Problems," September, 1954, Page 177.

CRISMAN, S. W. — "Modernization of Skelp Mill at Wheeling Steel's Benwood Works", August, 1954, Page 148.

D

DEBENHAM, W. S. — "Bricklaying as a Factor in the Performance of Blast Furnace Linings," March, 1954, Page 76.

DEILY, R. L. — "Use of Oxyacetylene in Rolling Mills," March, 1954, Page 83.

DIRTH, GEORGE P. — "Temper Mill Control," October, 1954, Page 81.

DUCHENE, JAMES L. — "Application of Bronze Bearing Alloys," May, 1954, Page 92.

DUDLEY, WRAY — "Estimating Motor Room Installation Costs," May, 1954, Page 87.

E

ELGE, E. A. — "Power Transformer Preventive Maintenance in the Steel Industry," August, 1954, Page 128.

ENOCHS, J. J. and KINCAID, REECE — "Improved Cleaning Techniques for Open Hearth Checkers," August, 1954, Page 79.

ESS, T. J. — "Kaiser Steel Corporation's Fontana Plant," February, 1954, Following Page 84.

ESS, T. J. — "Fairless Works — United States Steel's Newest," June, 1954, Page 76.

ESS, T. J. — "Jones & Laughlin . . . Pittsburgh Works," November, 1954, Page 75.

G

GIBSON, R. P. — "Economy Realized Through Strain Gage Checks," September, 1954, Page 88.

GOLDSTEIN, J. — "Economical Roll Reclamation," September, 1954, Page 112.

GRAHAM, D. C. and BRONLUND, L. R. — "Transformer Materials," August, 1954, Page 118.

GRAHAM, ROBERT W. — "Crane Power Limit Switches," May, 1954, Page 98.

GROSVENOR, GEORGE — "Atomization of Liquid Fuels by High Pressure Natural Gases," October, 1954, Page 77.

H

HALL, H. S. — "Effect of Secondary Checkers on Open Hearth Furnaces," November, 1954, Page 112.

HALL, ROBERT — "Rebuilding Steel Mill Rolls," September, 1954, Page 109.

HAMILTON, C. P. — "Integrated Electrical Equipment for Blast Furnace Operation," April, 1954, Page 89.

HARRIS, W. R. and STRINGER, L. F. — "Tension Regulator on Kaiser Temper Mill," August, 1954, Page 71.

HARRY, R. J. — "A Safety Limit Stop," May, 1954, Page 104.

HAYS, ERLE M. — "Imported Ore Handling — Machines and Practices," August, 1954, Page 84.

HEADLEE, J. F. — "Cathodic Protection for Steel Mill Grounding Systems," March, 1954, Page 113.

HESS, FREDERIC O. — "Heat Processing in Industry — Facts and Figures," February, 1954, Page 67.

HOGAN, W. T., S. J. — "Impact of Technical Developments in Light Flat Rolling on the Consuming Industries," February, 1954, Page 67.

HOWELL, HAROLD I. — "Power Generation Expansion," May, 1954, Page 132.

J

JOHANNSEN, K. L. — "Maintenance Aspects of Corrosion Program at Fairless Works," September, 1954, Page 115.

JONES, WALTER L., JR. — "Selling Safety," December, 1954, Page 96.

JORDAN, ROBERT M. — "Cleaning of Open Hearth Checkers and Sewers During Operation," July, 1954, Page 98.

K

KEISER, A. C., JR., PERSO, E. E., MANDY, W. H. AND CLARK, M. S. — "Steel Mill Lubrication Problems," September, 1954, Page 177.

KINCAID, REECE and ENOCHS, J. J. — "Improved Cleaning Techniques for Open Hearth Checkers," August, 1954, Page 79.

KING, A. D. — "Productive Maintenance," September, 1954, Page 98.

KIPP, DR. E. M. and SARGENT, DR. L. B., JR. — "Activated Alumina for the Maintenance of Gas Engine Crankcase Oils," October, 1954, Page 73.

KRANER, HOBART M. — "Trends in Blast Furnace Linings," July, 1954, Page 79.

KRAPF, GEORGE H. — "Gas Turbines for the Steel Industry," April, 1954, Page 97.

KUKA, K. S. — "Control of Electric Power Systems in Steel Plants," March, 1954, Page 105.

L

LEISTER, R. G. — "Lubrication Practices at Alan Wood Steel Co.," November, 1954, Page 138.

LEVOY, L. G. — "The Application of Transformers in the Steel Industry," August, 1954, Page 124.

LOHREY, CLARENCE R. — "Coke Plant and Blast Furnace Expansion at Fontana," July, 1954, Page 67.

LORIG, E. T. — "Application and Use of Self-Centering Rolls," January, 1954, Page 59.

LUCAS, R. T. — "Use of Magnetic Amplifiers in Control Circuits," January, 1954, Page 74.

M

McCLUNG, W. J. — "The Diversity of Products of Low Individual Tonnages," April, 1954, Page 101.

McCRADY, D. C. and WRIGHT, W. G. — "Adjustable Voltage Coal Bridge Installed at Steel Co. of Canada," May, 1954, Page 126.

D. C. McCRADY — "Control and Drive Equipment on D-C Electric Traveling Crane Bridges," July, 1954, Page 55.

McDONALD, E. C. — "Republic's New Open Hearth Furnaces at Cleveland," June, 1954, Page 99.

McMICHAEL, ROBERT C. — "Direct Rolling of Carbon Steel Ingots to Plates on Three-High and Four-High Plate Mills," March, 1954, Page 91.

MADSEN, I. E. — "Developments in the Iron and Steel Industry During 1953," January, 1954, Page 120.

MADSEN, I. E. — "Coke and By-Products in 1953," December, 1954, Page 87

MANDY, W. H., CLARK, M. S., KEISER, A. C., JR. and PERSO, E. E. — "Steel Mill Lubrication Problems," September, 1954, Page 177.

MARRS, R. E. — "Electrical Systems for Hot Strip Mills," February, 1954, Page 99.

MARTIN, W. M. — "Developments in Communications," February, 1954, Page 95.

MAVIS, FREDERIC T., BONETTI, JUAN M. and PECK, CHARLES F., JR. — "Temperature Stresses in Iron Work Rolls," June, 1954, Page 45.

MICAN, G. S. — "A New Theory of Hot Rolling," May, 1954, Page 55.

MILLER, W. E. — "Electric Systems for Main Drives," July, 1954, Page 83.

MIRSEPASSI, TAGHI and PASCHKIS, PROFESSOR V. — "Temperature Distribution in the Hearths of Blast Furnaces," February, 1954, Page 53.

MONTORO, J. C. — "Use of Models for Layout and Planning," September, 1954, Page 154.

MOORE, DAVID D. — "Cost Comparisons of the Open Hearth and Electric Furnace," March, 1954, Page 55.

N

NEBOLSINE, ROSS — "Water Supply for Steel Plants," April, 1954, Page 78.

NOBLE, R. E. — "Trends in Recent Cold Mill Installations," July, 1954, Page 105.

P

PASCHKIS, PROFESSOR V. and MIRSEPASSI, TAGHI — "Temperature Distribution in the Hearths of Blast Furnaces," February, 1954, Page 53.

PECK, CHARLES F., JR., BONETTI, JUAN M. and MAVIS, FREDERIC T. — "Temperature Stresses in Iron Work Rolls," June, 1954, Page 45.

PERSO, E. E., MANDY, W. H., CLARK, M. S. and KEISER, A. C., JR. — "Steel Mill Lubrication Problems," September, 1954, Page 177.

PETERSON, C. E. and ALLISON, F. H., JR. — "Modern Manufacture and Use of Cast Rolling Mill Rolls," December, 1954, Page 68.

PETERSON, E. C. — "Mechanical Features of Bar and Rod Mills," November, 1954, Page 103.

PINNEY, JAMES A. B. — "6900-Volt Power System Fault Relay Analysis," January, 1954, Page 99.

PRITCHARD, C. E. — "Safety in Operations," December, 1954, Page 97.

PULLEN, F. R. — "Soaking Pit Fuel Selection," March, 1954, Page 80.

PRUDEN, W. F. and YOUNG, JOHN L. — "United States Steel in the West," April, 1954, Page 57.

Q

QUESNEL, J. B. — "Surveying for Safety," December, 1954, Page 101.

R

RAAFLAUB, H. E. and BARNS, B. D. — "New Soaking Pit Facilities at Steel Division of Ford Motor Co.," May, 1954, Page 109.

RECTENWALD, R. L. — "Ultrasonics in Maintenance Planning and Product Quality Control," September, 1954, Page 77.

REED, MALCOLM W. — "More Than Technology," June, 1954, Page 77.

REES, W. D. — "Use of Plastic, Castable, and Gunning Materials in Soaking Pits," June, 1954, Page 59.

REINARTZ, L. F. and BARNES, H. C. — "Electric Furnace vs Open Hearth in Cold Metal Shops," January, 1954, Page 114.

RICHARDSON, G. S. — "Foundation Design for Iron & Steel Plants," April, 1954, Page 73.

RITTER, WAYNE G. — "Application of Lubricants to Rolling Mills — Problems, Developments and Trends," December, 1954, Page 78.

ROBERTSON, H. A. — "Refractory Types and Applications," January, 1954, Page 86.

RODDER, WILLIAM — "Recent Advancement in Continuous Butt and Induction Weld Pipe Mills," August, 1954, Page 108.

ROLLINS, J. D. — "Engineering Conception of Fairless Works," December, 1954, Page 115.

RUBIN, NORBERT C. — "The Modern Electric Weld Pipe and Casing Mill," April, 1954, Page 120.

RUGER, H. D. — "Extensions to Electrical Generating and Distribution Systems at Bethlehem's Sparrows Point Plant," November, 1954, Page 133.

S

SARGENT, DR. L. B., JR. and KIPP, DR. E. M. — "Activated Alumina for the Maintenance of Gas Engine Crankcase Oils," October, 1954, Page 73.

SCAROLA, PHILIP and BRANDT, C. C. — "Combination Bar and Rod Mill — Los Angeles Plant," July, 1954, Page 72.

SCHEU, DONALD T. — "Design and Application of Conveyor Belts for the Steel Industry," October, 1954, Page 117.

SCHWABE, W. E. — "Determination of the Optimum Current in an Arc Furnace," June, 1954, Page 87.

SMITH, C. E. — "Control for A Modern Electric Weld Pipe and Casing Mill," April, 1954, Page 124.

SPADONE, CHARLES D. — "Oilless Bearings — Their Place in Industry," September, 1954, Page 185.

STRINGER, L. F. and HARRIS, W. R. — "Tension Regulator on Kaiser Temper Mill," August, 1954, Page 71.

T

THACKER, H. B. — "Grounded versus Ungrounded Low-Voltage A-C Systems," April, 1954, Page 65.

THURMAN, ASTOR L. — "A Mechanical Extrusion Press for Producing Tubes and Bars," November, 1954, Page 64.

TYSON, J. D. — "Intra-Plant Handling of Round Billets and Pipe with Special Automotive Equipment," June, 1954, Page 107.

V

VER SNYDER, F. L. — "Problems in Developing Alloy Steels for Aircraft Gas Turbines," May, 1954, Page 115.

VIEROW, E. A. — "Metallic Recuperators in the Steel Industry," August, 1954, Page 57.

VONADA, E. E. — "Unusual Electrical Drive Features Applied to Fairless Processing Lines," April, 1954, Page 114.

VONADA, E. E. — "Helper Drives Help Steel Processing Lines," September, 1954, Page 192.

W

WALLIS, W. B. — "The Electric Furnace West of the Rockies," May, 1954, Page 80.

WARCHOL, JOHN A., JR. — "Maintenance of Slag Bottom Soaking Pits," December, 1954, Page 121.

WARREN, R. G. and AARONS, J. S. — "Pumpability of Steel Mill Greases — Parts I and II," October, 1954, Page 67.

WEBSTER, CLARENCE J. — "Combination Fuel Firing of Boiler Plants," July, 1954, Page 70.

WEESNER, ROBERT J. — "Application of Magnetic Amplifiers," October, 1954, Page 101.

WHEELER, W. C. — "Growth Possibilities of Electric Furnace Carbon Steel," February, 1954, Page 85.

WILLIAMSON, H. V. — "Use of Low Pressure Carbon Dioxide for Fire Control," October, 1954, Page 107.

WOHLGEMUTH, M. J. — "Field Repair of Large Rotating Machinery," September, 1954, Page 106.

WRIGHT, W. G. and McCRADY, D. C. — "Adjustable Voltage Coal Bridge Installed at Steel Co. of Canada," May, 1954, Page 126.

Y

YOUNG, JOHN L. and PRUDEN, W. F. — "United States Steel in the West," April, 1954, Page 57.

Z

ZELLEY, W. E. and BURDEN, C. H. — "Increasing Rod Production by Conversion of a 2-Strand Rod Mill to 3-Strand Operation," December, 1954, Page 55.

LIST OF SUBJECTS

A

"Activated Alumina for the Maintenance of Gas Engine Crankcase Oils" — By DR. L. B. SARGENT, JR. and DR. E. M. KIPP, October, 1954, Page 73.

"Adjustable Voltage Coal Bridge Installed at Steel Co. of Canada" — By W. G. WRIGHT and D. C. McCRADY, May, 1954, Page 126.

"Air Pollution Control in the Bethlehem Steel Co." — By ALLEN D. BRANDT, August, 1954, Page 103.

"AISE Annual Convention and Iron and Steel Exposition, Program — 1954" — September, 1954, Page 128.

"AISE Annual Convention — Pictorial Review" — October, 1954, Page 94.

"AISE Annual Spring Conference, Program" — April, 1954, Page 105.

"AISE District Chairmen 1954-55" — November, 1954, Page 144.

"AISE Spring Conference Pictorial Review — 1954" — May, 1954, Page 124.

"AISE West Coast Meeting — Pictorial Review" — March, 1954, Page 116.

"Alan Wood Steel Co., Lubrication Practices at" — By R. G. LEISTER, November, 1954, Page 138.

"American Iron and Steel Institute, Program of the" — August, 1954, Page 136.

"Amplifiers, Application of Magnetic" — By ROBERT J. WEESNER, October, 1954, Page 101.

"Amplifiers in Control Circuits, Use of Magnetic" — By R. T. LUCAS, January, 1954, Page 74.

"Application and Use of Self-Centering Rolls" — By E. T. LORIG, January, 1954, Page 59.

"Application of Bronze Bearing Alloys" — By JAMES L. DUCHENE, May, 1954, Page 92.

"Application of Lubricants to Rolling Mills — Problems, Developments and Trends" — By WAYNE G. RITTER, December, 1954, Page 78.

"Application of Magnetic Amplifiers" — By ROBERT J. WEESNER, October, 1954, Page 101.

"Application of Transformers in the Steel Industry, The" — By L. G. LEVOY, August, 1954, Page 124.

"Applications for Laminated Fabric Bearings" — By R. L. BERRY, September, 1954, Page 161.

"Arc Furnace, Determination of the Optimum Current in an" — By W. E. SCHWABE, June, 1954, Page 87.

"Arc Furnace Equipment and Practices, Modern" — By E. H. BROWNING, March, 1954, Page 71.

"Association of Iron and Steel Engineers, National Committees for 1954" — January, 1954, Page 97.

"Association of Iron and Steel Engineers 1954, Newly Elected Officers and Directors" — January, 1954, Page 94.

"Atomization of Liquid Fuels by High Pressure Natural Gases" — By GEORGE GROSVENOR, October, 1954, Page 77.

B

"Bar and Rod Mills, Mechanical Features of" — By E. C. PETERSON, November, 1954, Page 103.

"Bearing Alloys, Application of Bronze" — By JAMES L. DUCHENE, May, 1954, Page 92.

"Bearings, Applications for Laminated Fabric" — By R. L. BERRY, September, 1954, Page 161.

"Bearings — Their Place in Industry, Oilless" — By CHARLES D. SPADONE, September, 1954, Page 185.

"Belts for the Steel Industry, Design and Application of Conveyor" — By DONALD T. SCHEU, October, 1954, Page 117.

"Bethlehem Steel Co., Air Pollution Control in the" — By ALLEN D. BRANDT, August, 1954, Page 103.

"Bethlehem's Sparrows Point Plant, Extensions to Electrical Generating and Distribution Systems at" — By H. D. RUGER, November, 1954, Page 133.

"Billets and Pipe with Special Automotive Equipment, Intra-Plant Handling of Round" — By J. D. TYSON, June, 1954, Page 107

"Blast Furnace Expansion at Fontana, Coke Plant and" — By CLARENCE R. LOHREY, July, 1954, Page 67.

"Blast Furnace Linings, Bricklaying as a Factor in the Performance of" — W. S. DEBENHAM, March, 1954, Page 76.

"Blast Furnace Linings, Trends in" — By HOBART M. KRANER, July, 1954, Page 79.

"Blast Furnace Operation, Integrated Electrical Equipment for" — By C. P. HAMILTON, April, 1954, Page 89.

"Blast Furnace, Temperature Distribution in the Hearths of" — By PROFESSOR V. PASCHKIS and TAGHI MIRSEPASSI, February, 1954, Page 53.

"Boiler Plants, Combination Fuel Firing of" — By CLARENCE J. WEBSTER, July, 1954, Page 70.

"Bricklaying as a Factor in the Performance of Blast Furnace Linings" — By W. S. DEBENHAM, March, 1954, Page 76.

"Bridge Installed at Steel Co. of Canada, Adjustable Voltage Coal" — By W. G. WRIGHT and D. C. McCRADY, May, 1954, Page 126.

"Burners for Edge Heating Skelp, Use of High Velocity" — By G. J. CAMPBELL, October, 1954, Page 111.

"By-Products in 1953, Coke and" — By I. E. MADSEN, December, 1954, Page 87.

C

"Carbon Dioxide for Fire Control, Use of Low Pressure" — By H. V. WILLIAMSON, October, 1954, Page 107.

"Castable and Gunning Materials in Soaking Pits, Use of Plastic" — By W. D. REES, June, 1954, Page 59.

"Cathodic Protection for Steel Mill Grounding Systems" — By J. F. HEADLEE, March, 1954, Page 113.

"Chairmen 1954-55, AISE District" — November, 1954, Page 144.

"Checkers and Sewers During Operation, Cleaning of Open Hearth" — By R. M. JORDAN, July, 1954, Page 105.

"Checkers on Open Hearth Furnaces, Effect of Secondary" — By H. S. HALL, November, 1954, Page 112.

"Cleaning of Open Hearth Checkers and Sewers During Operation" — By R. M. JORDAN, July, 1954, Page 98.

"Cleaning Techniques for Open Hearth Checkers, Improved" — By J. J. ENOCHS and REESE KINCAID, August, 1954, Page 79.

"Coke and By-Products in 1953" — By I. E. MADSEN, December, 1954, Page 87.

"Coke Plant and Blast Furnace Expansion at Fontana" — By CLARENCE R. LOHREY, July, 1954, Page 67.

"Combination Bar and Rod Mill — Los Angeles Plant" — By C. C. BRANDT and PHILIP SCAROLA, July, 1954, Page 72.

"Combination Fuel Firing of Boiler Plants" — By CLARENCE J. WEBSTER, July, 1954, Page 70.

"Communication at Lukens Steel Co., Modern Methods of" — By GILBERT P. CARDWELL, November, 1954, Page 127.

Communications, Developments in" — By W. M. MARTIN, February, 1954, Page 95.

"Conference Pictorial Review — 1954, AISE Spring" — May, 1954, Page 124.

"Control, Temper Mill" — By GEORGE P. DIRTH, October, 1954, Page 81.

"Control and Drive Equipment on D-C Electric Traveling Crane Bridges" — By D. C. McCRADY, July, 1954, Page 55.

"Control for A Modern Electric Weld Pipe and Casing Mill" — By C. E. SMITH, April, 1954, Page 124.

"Control of Electric Power Systems in Steel Plants" — By K. S. KUKA, March, 1954, Page 105.

"Conveyor Belts for the Steel Industry, Design and Application of" — By DONALD T. SCHEU, October, 1954, Page 117.

"Corrosion Program at Fairless Works, Maintenance Aspects" — By K. L. JOHANNSEN, September, 1954, Page 115.

"Cost Comparisons of the Open Hearth and Electric Furnace" — By DAVID D. MOORE, March, 1954, Page 55.

"Crane Bridges, Control and Drive Equipment on D-C Electric Traveling" — By D. C. McCRADY, July, 1954, Page 55.

"Crane Power Limit Switches" — By R. W. GRAHAM, May, 1954, Page 98.

D

"Daily Maintenance Cost Control — the Foreman's Tool" — By W. B. CARTER, September, 1954, Page 123.

"Design and Application of Conveyor Belts for the Steel Industry" — By DONALD T. SCHEU, October, 1954, Page 117.

"Design for Iron and Steel Plants, Foundation" — By GEORGE S. RICHARDSON, April, 1954, Page 73.

"Determination of the Optimum Current in an Arc Furnace" — By W. E. SCHWABE, June, 1954, Page 87.

"Developments in Communications" — By W. M. MARTIN, February, 1954, Page 95.

"Developments in the Iron and Steel Industry During 1953" — By I. E. MADSEN, January, 1954, Page 120.

"Direct Rolling of Carbon Steel Ingots to Plates on Three-High and Four-High Plate Mills" — By ROBERT C. McMICHAEL, March, 1954, Page 91.

"Distribution Systems at Bethlehem's Sparrows Point Plant, Extensions to Electrical Generating and" — By H. D. RUGER, November, 1954, Page 133.

"Diversity of Products of Low Individual Tonnages, The" — By W. J. McCLUNG, April, 1954, Page 101.

"Drawing of Steel Wire, Processing and" — By P. A. BEAMAN, October, 1954, Page 96.

"Drives, Electric Systems for Main" — By W. E. MILLER, July, 1954, Page 83.

"Drives Help Steel Processing Lines, Helper" — By E. E. VONADA, September, 1954, Page 192.

E

"Economical Roll Reclamation" — By J. GOLDSTEIN, September, 1954, Page 112.

"Economics of Replacement in the Steel Industry, The" — By G. G. BEARD, October, 1954, Page 55.

"Economy Realized Through Strain Gage Checks" — By R. P. GIBSON, September, 1954, Page 88.

"Effect of Secondary Checkers on Open Hearth Furnaces" — By H. S. HALL, November, 1954, Page 112.

"Electric Drive Features Applied to Fairless Processing Lines, Unusual" — By E. E. VONADA, April, 1954, Page 114.

"Electric Furnace Carbon Steel, Growth Possibilities of" — By WILLARD C. WHEELER, February, 1954, Page 85.

"Electric Furnace, Cost Comparisons of the Open Hearth and" — By DAVID D. MOORE, March, 1954, Page 55.

"Electric Furnace vs Open Hearth in Cold Metal Shops" — By L. F. REINARTZ and H. C. BARNES, January, 1954, Page 114.

"Electric Furnace West of the Rockies, The" — By W. B. WALLIS, May, 1954, Page 80.

"Electric Systems for Main Drives" — By W. E. MILLER, July, 1954, Page 79.

"Electric Weld Pipe and Casing Mill, Control for a Modern" — By C. E. SMITH, April, 1954, Page 124.

"Electric Weld Pipe and Casing Mill, The Modern" — By NORBERT C. RUBIN, April, 1954, Page 120.

"Electrical Power Distribution and Utilization at Lone Star Steel Co." — By R. G. ORTHWEIN, December, 1954, Page 104.

"Electrical Systems for Hot Strip Mills" — By R. E. MARRS, February, 1954, Page 99.

"Engineering Conception of Fairless Works" — By J. D. ROLLINS, December, 1954, Page 115.

"Estimating Motor Room Installation Costs" — By WRAY DUDLEY, May, 1954, Page 87.

"Extensions to Electrical Generating and Distribution Systems at Bethlehem's Sparrows Point Plant" — By H. D. RUGER, November, 1954, Page 133.

"Extrusion Press for Producing Tubes and Bars, A Mechanical" — By ASTOR L. THURMAN, November, 1954, Page 64.

F

"Factors Affecting Performance of High Temperature Greases" — By ELDON L. ARMSTRONG, September, 1954, Page 167.

"Fairless Processing Lines, Unusual Electric Drive Features Applied to" — By E. E. VONADA, April, 1954, Page 114.

"Fairless Works, Engineering Conception of" — By J. D. ROLLINS, December, 1954, Page 115.

"Fairless Works, Maintenance Aspects of Corrosion Program at" — By K. L. JOHANNSEN, September, 1954, Page 115.

"Fairless Works — United States Steel's Newest" — By T. J. ESS, June, 1954, Following Page 76.

"Field Repair of Large Rotating Machinery" — By M. J. WOHLGEMUTH, September, 1954, Page 106.

"Fire Control, Use of Low Pressure Carbon Dioxide for" — By H. V. WILLIAMSON, October, 1954, Page 107.

"Flat Rolling on the Consuming Industries, Impact of Technical Developments in Light" — By WILLIAM T. HOGAN, S. J., February, 1954, Page 67.

"Fontana, Coke Plant and Blast Furnace Expansion at" — By CLARENCE R. LOHREY, July, 1954, Page 67.

"Fontana Plant, Kaiser Steel Corp.'s" — By T. J. ESS, February, 1954, Following Page 84.

"Ford Motor Co., New Soaking Pit Facilities at Steel Division of" — By B. D. BARNS and H. E. RAAFLAUB, May, 1954, Page 109.

"Foundation Design for Iron and Steel Plants" — By GEORGE S. RICHARDSON, April, 1954, Page 73.

"Four-High Plate Mills, Direct Rolling of Carbon Steel Ingots to Plates on Three-High and" — By ROBERT C. McMICHAEL, March, 1954, Page 91.

"Fuel Selection for Soaking Pits" — By F. R. PULLEN, March, 1954, Page 80.

"Fuels by High Pressure Natural Gases, Atomization of Liquid" — By GEORGE GROSVENOR, October, 1954, Page 77.

"Furnace, Cost Comparisons of the Open Hearth and Electric" — By DAVID D. MOORE, March, 1954, Page 55.

"Furnace Equipment and Practices, Modern Arc" — By E. H. BROWNING, March, 1954, Page 71.

"Furnace Linings, Bricklaying as a Factor in the Performance of Blast" — By W. S. DEBENHAM, March, 1954, Page 76.

"Furnace West of the Rockies, The Electric" — By W. B. WALLIS, May, 1954, Page 80.

G

"Gages in Steel Plants, Uses of Resistance Wire Type Strain" — By W. A. BLACK, November, 1954, Page 57.

"Gas Engine Crankcase Oils, Activated Alumina for the Maintenance of" — By DR. L. B. SARGENT, JR. and DR. E. M. KIPP, October, 1954, Page 73.

"Gas Turbines for the Steel Industry" — By GEORGE H. KRAPF, April, 1954, Page 97.

"Gas Turbines, Problems in Developing Alloy Steels for Aircraft" — By F. L. VER SNYDER, May, 1954, Page 115.

"Gases, Atomization of Liquid Fuels by High Pressure Natural" — By GEORGE GROSVENOR, October, 1954, Page 77.

"Generating and Distribution Systems at Bethlehem's Sparrows Point Plant, Extensions to Electrical" — By H. D. RUGER, November, 1954, Page 133.

"Greases, Factors Affecting Performance of High Temperature" — By ELDON L. ARMSTRONG, September, 1954, Page 167.

"Greases, Pumpability of Steel Mill" — Part I — J. S. AARONS, Part II — R. G. WARREN, October, 1954, Page 67.

"Grounded Versus Ungrounded Low-Voltage A-C Systems" — By H. B. THACKER, April, 1954, Page 65.

"Grounding Systems, Cathodic Protection for Steel Mill" — By J. F. HEADLEE, March, 1954, Page 113.

"Growth Possibilities of Electric Furnace Carbon Steel" — By WILLARD C. WHEELER, February, 1954, Page 85.

"Gunning Materials in Soaking Pits, Use of Plastic, Castable and" — By W. D. REES, June, 1954, Page 59.

H

"Handling of Round Billets and Pipe with Special Automotive Equipment, Intra-Plant" — By J. D. TYSON, June, 1954, Page 107.

"Hearths of Blast Furnaces, Temperature Distribution in the" — By PROFESSOR V. PASCHKIS and TAGHI MIRSEPASSI, February, 1954, Page 53.

"Heat Processing in Industry — Facts and Figures" — By FREDERICK O. HESS, February, 1954, Page 73.

"Helper Drives Help Steel Processing Lines" — By E. E. VONADA, September, 1954, Page 192.

I

"Impact of Technical Developments in Light Flat Rolling on the Consuming Industries" — By WILLIAM T. HOGAN, S. J., February, 1954, Page 67.

"Import Ore Handling-Machines and Practices" — By ERLE M. HAYS, August, 1954, Page 84.

"Improved Cleaning Techniques for Open Hearth Checkers" — By J. J. ENOCHS and REECE KINCAID, August, 1954, Page 79.

"Increasing Rod Production by Conversion of a 2-Strand Rod Mill to 3-Strand Operation" — By C. H. BURDEN and W. E. ZELLEY, December, 1954, Page 55.

"Integrated Electrical Equipment for Blast Furnace Operation" — By C. P. HAMILTON, April, 1954, Page 89.

"Intra-Plant Handling of Round Billets and Pipe with Special Automotive Equipment" — By J. D. TYSON, June, 1954, Page 107.

J

"Jones & Laughlin . . . Pittsburgh Works" — By T. J. ESS, November, 1954, Page 75.

K

"Kaiser Steel Corporation's Fontana Plant" — By T. J. ESS, February, 1954, Following Page 84.

"Kaiser Temper Mill, Tension Regulator on" — By W. R. HARRIS and L. F. STRINGER, August, 1954, Page 71.

L

"Layout and Planning, Use of Models for" — By J. C. MONTORO, September, 1954, Page 154.

"Limit Stop, A Safety" — By R. J. HARRY, May, 1954, Page 104.

"Limit Switches, Crane Power" — By R. W. GRAHAM, May, 1954, Page 98.

"Lone Star Steel Co., Electrical Power Distribution and Utilization at" — By R. G. ORTHWEIN, December, 1954, Page 104.

"Lubricants to Rolling Mills — Problems, Developments and Trends, Application of" — By WAYNE G. RITTER, December, 1954, Page 78.

"Lubrication Practices at Alan Wood Steel Co." — By R. G. LEISTER, November, 1954, Page 138.

"Lubrication Problems, Steel Mill" — By A. C. KEISER, JR., E. E. PERSO W. H. MANDY and M. S. CLARK, September, 1954, Page 177.

"Lukens Steel Co., Modern Methods of Communication at" — By GILBERT P. CARDWELL, November, 1954, Page 127.

M

"Maintenance Aspects of Corrosion Program at Fairless Works" — By K. L. JOHANNSEN, September, 1954, Page 115.

"Maintenance Cost Control — the Foreman's Tool, Daily" — By W. B. CARTER, September, 1954, Page 123.

"Maintenance, Metallurgical Aspects of Plant" — By T. G. BRADBURY, September, 1954, Page 90.

"Maintenance of Slag Bottom Soaking Pits" — By JOHN A. WARCHOL, JR., December, 1954, Page 121.

"Maintenance Planning and Product Quality Control Ultrasonics in" — By R. L. RECTENWALD, September, 1954, Page 77.

"Maintenance, Productive" — By A. D. KING, September, 1954, Page 98.

"Maintenance, Transformer" — By B. L. BRITT, September, 1954, Page 101.

"Mechanical Extrusion Press for Producing Tubes and Bars, A" — By ASTOR L. THURMAN, November, 1954, Page 64.

"Mechanical Features of Bar and Rod Mills" — By E. C. PETERSON, November, 1954, Page 103.

"Metallic Recuperators in the Steel Industry" — By E. A. VIEROW, August, 1954, Page 57.

"Metallurgical Aspects of Plant Maintenance" — By T. G. BRADBURY, September, 1954, Page 90.

"Mill Installations, Trends in Recent Cold" — By R. E. NOBLE, July, 1954, Page 105.

"Mill — Los Angeles Plant, Combination Bar and Rod" — By C. C. BRANDT and PHILIP SCAROLA, July, 1954, Page 72.

"Mill Rolls, Modern Manufacture and Use of Cast Rolling" — By F. H. ALLISON, JR. and C. E. PETERSON, December, 1954, Page 68.

"Mills, Direct Rolling of Carbon Steel Ingots to Plates on Three-High and Four-High Plate" — By ROBERT C. McMICHAEL, March, 1954, Page 91.

"Mills, Mechanical Features of Bar and Rod" — By E. C. PETERSON, November, 1954, Page 103.

"Mills — Problems, Developments and Trends, Application of Lubricants to Rolling" — By WAYNE G. RITTER, December, 1954, Page 78.

"Mills, Use of Oxyacetylene in Rolling" — By R. L. DEILY, March, 1954, Page 83.

"Models for Layout and Planning, Use of" — By J. C. MONTORO, September, 1954, Page 154.

"Modern Arc Furnace Equipment and Practices" — By E. H. BROWNING, March, 1954, Page 71.

"Modern Electric Weld Pipe and Casing Mill, The" — By NORBERT C. RUBIN, April, 1954, Page 120.

"Modern Manufacture and Use of Cast Rolling Mill Rolls" — By F. H. ALLISON, JR. and C. E. PETERSON, December, 1954, Page 68.

"Modern Methods of Communication at Lukens Steel Co." — By GILBERT P. CARDWELL, November, 1954, Page 127.

"Modernization of Skelp Mill at Wheeling Steel's Benwood Works" — By S. W. CRISMAN, August, 1954, Page 148.

"More Than Technology" — By MALCOLM W. REED, June, 1954, Page 77.

"Motor Room Installation Costs, Estimating" — By WRAY DUDLEY, May, 1954, Page 87.

N

"National Committees for 1954, Association of Iron and Steel Engineers" — January, 1954, Page 97.

"New Open Hearth Furnaces at Stelco" — By E. T. W. BAILEY, June, 1954, Page 91.

"New Soaking Pit Facilities at Steel Division of Ford Motor Co." — By B. D. BARNS and H. E. RAAFLAUB, May, 1954, Page 109.

"New Theory of Hot Rolling, A" — By GEORGE S. MICAN, May, 1954, Page 55.

"Newly Elected Officers and Directors, Association of Iron and Steel Engineers 1954" — January, 1954, Page 94.

O

"Officers and Directors, Association of Iron and Steel Engineers 1954, Newly Elected" — January, 1954, Page 94.

"Oilless Bearings — Their Place in Industry" — By CHARLES D. SPADONE, September, 1954, Page 185.

"Oils, Activated Alumina for the Maintenance of Gas Engine Crankcase" — By DR. L. B. SARGENT, JR. and DR. E. M. KIPP, October, 1954, Page 73.

"Open Hearth and Electric Furnace, Cost Comparisons of the" — By DAVID D. MOORE, March, 1954, Page 55.

"Open Hearth Checkers and Sewers During Operation, Cleaning of" — By R. M. JORDAN, July, 1954, Page 98.

"Open Hearth Checkers, Improved Cleaning Techniques for" — By J. J. ENOCHS and REECE KINCAID, August, 1954, Page 79.

"Open Hearth Furnaces at Cleveland, Republic's New" — By E. C. McDONALD, June, 1954, Page 99.

"Open Hearth Furnaces at Stelco, New" — By E. T. W. BAILEY, June, 1954, Page 91.

"Open Hearth Furnaces, Effect of Secondary Checkers on" — By H. S. HALL, November, 1954, Page 112.

"Open Hearth in Cold Metal Shops, Electric Furnace vs" — By L. F. REINARTZ and H. C. BARNES, January, 1954, Page 114.

"Ore Handling-Machines and Practices, Import" — By ERLE M. HAYS, August, 1954, Page 84.

"Oxyacetylene in Rolling Mills, Use of" — By R. L. DEILY, March, 1954, Page 83.

"Oxygen in Steel Mills, Use of" — By GLENN O. CARTER, June, 1954, Page 80.

P

"Philadelphia Regional Safety and Fire Conference — Selling Safety" — By WALTER L. JONES, JR., Page 96; "Safety in Operations" — By C. E. PRITCHARD, Page 97; "Surveying for Safety" — By J. B. QUESNEL, Page 101, December, 1954.

"Pictorial Review — AISE West Coast Meeting" — March, 1954, Page 116.

"Pictorial Review — AISE Annual Convention" — October, 1954, Page 94.

"Pipe and Casing Mill, Control for A Modern Electric Weld" — By C. E. SMITH, April, 1954, Page 124.

"Pipe and Casing Mill, The Modern Electric Weld" — By NORBERT C. RUBIN, April, 1954, Page 120.

"Pipe Mills, Recent Advancements in Continuous Butt and Induction Weld" — By WILLIAM RODDER, August, 1954, Page 108.

"Pipe with Special Automotive Equipment, Intra-Plant Handling of Round Billets and" — By J. D. TYSON, June, 1954, Page 107.

"Pits, Maintenance of Slag Bottom Soaking" — By JOHN A. WARHOL, JR., December, 1954, Page 121.

"Pittsburgh Works . . . Jones & Laughlin" — By T. J. ESS, November, 1954, Page 75.

"Plastic, Castable and Gunning Materials in Soaking Pits, Use of" — By W. D. REES, June, 1954, Page 59.

"Plates on Three-High and Four-High Plate Mills, Direct Rolling of Carbon Steel Ingots to" — By ROBERT C. McMICHAEL, March, 1954, Page 91.

"Power Distribution and Utilization at Lone Star Steel Co., Electrical" — By R. G. ORTHWEIN, December, 1954, Page 104.
"Power Generation Expansion" — By HAROLD I. HOWELL, May, 1954, Page 132.
"Power System Fault Relay Analysis, 6900-Volt" — By JAMES A. B. PINNEY, January, 1954, Page 99.
"Power Systems in Steel Plants, Control of Electric" — By K. S. KUKA, March, 1954, Page 105.
"Power Transformer Preventive Maintenance in the Steel Industry" — By E. A. ELGE, August, 1954, Page 128.
"Problems in Developing Alloy Steels for Aircraft Gas Turbines" — By F. L. VER SNYDER, May, 1954, Page 115.
"Processing and Drawing of Steel Wire" — By P. A. BEAMAN, October, 1954, Page 96.
"Processing Lines, Helper Drives Help Steel" — By E. E. VONADA, September, 1954, Page 192.
"Processing Lines, System Engineering for Continuous Strip" — By J. S. APPERSON, June, 1954, Page 68.
"Productive Maintenance" — By A. D. KING, September, 1954, Page 98.
"Program AISE Annual Spring Conference" — April, 1954, Page 105.
"Program of the American Iron and Steel Institute" — August, 1954, Page 136.
"Program — 1954 AISE Annual Convention and Iron and Steel Exposition" — September, 1954, Page 128.
"Pumpability of Steel Mill Greases" — Part I — By J. S. AARONS; Part II — By R. G. WARREN, October, 1954, Page 67.

R

"Rebuilding Steel Mill Rolls" — By ROBERT HALL, September, 1954, Page 109.
"Recent Advancements in Continuous Butt and Induction Weld Pipe Mills" — By WILLIAM RODDER, August, 1954, Page 108.
"Recuperators in the Steel Industry, Metallic" — By E. A. VIEROW, August, 1954, Page 57.
"Refractory Types and Applications" — By H. A. ROBERTSON, January, 1954, Page 86.
"Relay Analysis, 6900-Volt Power System Fault" — By JAMES A. B. PINNEY, January, 1954, Page 99.
"Replacement in the Steel Industry, The Economics of" — By G. G. BEARD, October, 1954, Page 55.
"Republic's New Open Hearth Furnaces at Cleveland" — By E. C. McDONALD, June, 1954, Page 99.
"Rod Mill to 3-Strand Operation, Increasing Rod Production by Conversion of a 2-Strand" — By C. H. BURDEN and W. E. ZELLEY, December, 1954, Page 55.
"Rod Mills, Mechanical Features of Bar and" — By E. C. PETERSON, November, 1954, Page 103.
"Roll Reclamation, Economical" — By J. GOLDSTEIN, September, 1954, Page 112.
"Rolls, Application and Use of Self-Centering" — By E. T. LORIG, January, 1954, Page 59.
"Rolls, Modern Manufacture and Use of Cast Rolling Mill" — By F. H. ALLISON, JR. and C. E. PETERSON, December, 1954, Page 68.
"Rolls, Rebuilding Steel Mill" — By ROBERT HALL, September, 1954, Page 109.
"Rolls, Temperature Stresses in Iron Work" — By CHARLES F. PECK, JR., JUAN M. BONETTI and FREDERIC T. MAVIS, June, 1954, Page 45.
"Rolling, A New Theory of Hot" — By GEORGE S. MICAN, May, 1954, Page 55.
"Rolling on the Consuming Industries, Impact of Technical Developments in Light Flat" — By WILLIAM T. HOGAN, S. J., February, 1954, Page 67.

S

"Safety in Operations" — By C. E. PRITCHARD, December, 1954, Page 97.
"Safety Limit Stop, A" — By R. J. HARRY, May, 1954, Page 104.
"Safety, Selling" — By WALTER L. JONES, JR., December, 1954, Page 96.
"Safety, Surveying for" — By J. B. QUESNEL, December, 1954, Page 101.
"Self-Centering Rolls, Application and Use of" — By E. T. LORIG, January, 1954, Page 59.
"Selling Safety" — By WALTER L. JONES, JR., December, 1954, Page 96.
"Skelp Mill at Wheeling Steel's Benwood Works, Modernization of" — By S. W. CRISMAN, August, 1954, Page 148.
"Skelp, Use of High Velocity Burners for Edge Heating" — By G. J. CAMPBELL, October, 1954, Page 111.
"Soaking Pit Facilities at Steel Division of Ford Motor Co., New" — By B. E. BARNS and H. E. RAAFLAUB, May, 1954, Page 109.
"Soaking Pits, Fuel Selection for" — By F. R. PULLEN, March, 1954, Page 80.
"Soaking Pits, Maintenance of Slag Bottom" — By JOHN A. WARCHOL, JR., December, 1954, Page 121.
"Soaking Pits, Use of Plastic, Castable and Gunning Materials in" — By W. D. REES, June, 1954, Page 59.
"Spring Conference, Program AISE Annual" — April, 1954, Page 105.
"Steel in the West, United States" — By JOHN L. YOUNG and W. F. PRUDEN, April, 1954, Page 57.
"Steel Mill Lubrication Problems" — By A. C. KEISER, JR., E. E. PERSO, W. H. MANDY and M. S. CLARK, September, 1954, Page 177.
"Stelco, New Open Hearth Furnaces at" — By E. T. W. BAILEY, June, 1954, Page 91.
"Strain Gage Checks, Economy Realized Through" — By R. P. GIBSON, September 1954, Page 88.
"Strain Gages in Steel Plants, Uses of Resistance Wire Type" — By W. A. BLACK, November, 1954, Page 57.
"Strip Mills, Electrical Systems for Hot" — By R. E. MARRS, February, 1954, Page 99.
"Strip Processing Lines, System Engineering for Continuous" — By J. S. APPERSON, June, 1954, Page 68.
"Surveying for Safety" — By J. B. QUESNEL, December, 1954, Page 101.
"System Engineering for Continuous Strip Processing Lines" — By J. S. APPERSON, June, 1954, Page 68.

T

"Temper Mill Control" — By GEORGE P. DIRTH, October, 1954, Page 81.
"Temper Mill, Tension Regulator on Kaiser" — By W. R. HARRIS and L. F. STRINGER, August, 1954, Page 71.
"Temperature Distribution in the Hearths of Blast Furnaces" — By PROFESSOR V. PASCHKIS and TAGHI MIRSEPASSI, February, 1954, Page 53.
"Temperature Stresses in Iron Work Rolls" — By CHARLES F. PECK, JR., JUAN M. BONETTI and FREDERIC T. MAVIS, June, 1954, Page 45.
"Tension Regulator on Kaiser Temper Mill — By W. R. HARRIS and L. F. STRINGER, August, 1954, Page 71.
"Three-High and Four-High Plate Mills, Direct Rolling of Carbon Steel Ingots to Plates on" — By ROBERT C. McMICHAEL, March, 1954, Page 91.
"Transformer Maintenance" — By B. L. BRITT, September, 1954, Page 101.
"Transformer Materials" — By D. C. GRAHAM and L. R. BRONLUND, August, 1954, Page 118.
"Transformer Preventive Maintenance in the Steel Industry, Power" — By E. A. ELGE, August, 1954, Page 128.
"Transformers for the Steel Industry — Transformer Materials" — By D. C. GRAHAM and L. R. BRONLUND; "The Application of Transformers in the Steel Industry" — By L. G. LEVOY; "Power Transformer Preventive Maintenance in the Steel Industry" — By E. A. ELGE, August, 1954, Page 128.
"Transformers in the Steel Industry, The Application of" — By L. G. LEVOY, August, 1954, Page 124.
"Trends in Blast Furnace Linings" — By HOBART M. KRANER, July, 1954, Page 79.
"Trends in Recent Cold Mill Installations" — By R. E. NOBLE, July, 1954, Page 105.
"Turbines for the Steel Industry, Gas" — By GEORGE H. KRAPF, April, 1954, Page 97.

U

"Ultrasonics in Maintenance Planning and Product Quality Control" — By R. L. RECTENWALD, September, 1954, Page 77.
"United States Steel in the West" — By JOHN L. YOUNG and W. F. PRUDEN, April, 1954, Page 57.
"United States Steel's Newest — Fairless Works" — By T. J. ESS, June, 1954, Following Page 76.
"Unusual Electric Drive Features Applied to Fairless Processing Lines" — By E. E. VONADA, April, 1954, Page 114.
"Use of High Velocity Burners for Edge Heating Skelp" — By G. J. CAMPBELL, October, 1954, Page 111.
"Use of Low Pressure Carbon Dioxide for Fire Control" — By H. V. WILLIAMSON, October, 1954, Page 107.
"Use of Magnetic Amplifiers in Control Circuits" — By R. T. LUCAS, January, 1954, Page 74.
"Use of Models for Layout and Planning" — By J. C. MONTORO, September, 1954, Page 154.
"Use of Oxyacetylene in Rolling Mills" — By R. L. DEILY, March, 1954, Page 83.
"Use of Oxygen in Steel Mills" — By GLENN O. CARTER, June, 1954, Page 80.
"Use of Plastic, Castable and Gunning Materials in Soaking Pits" — By W. D. REES, June, 1954, Page 59.
"Uses of Resistance Wire Type Strain Gages in Steel Plants" — By W. A. BLACK, November, 1954, Page 57.

W

"Water Supply for Steel Plants" — By ROSS NEBOLSINE, April, 1954, Page 78.
"Wire, Processing and Drawing of Steel" — By P. A. BEAMAN, October, 1954, Page 96.
"1953, Developments in the Iron and Steel Industry During" — By I. E. MADSEN, January, 1954, Page 120.
"6900-Volt Power System Fault Relay Analysis" — By JAMES A. B. PINNEY, January, 1954, Page 99.

INDEX TO ADVERTISER

DECEMBER, 1954

A

Aetna-Standard Engineering Co. 1
Air Reduction Sales Co. 28
Ajax Flexible Coupling Co. 200
Aldrich Pump Co., The 197
Alliance Machine Co. 140
Allis-Chalmers Manufacturing Co. 10, 11
American Air Filter Co. 15
American Brake Shoe Co., Electro-Alloys Division 139
American Bridge Division, United States Steel Corp. 143
American Wheelabrator and Equipment Corp 8
Ampco Metal, Inc. 192
Askania Regulator Co. 35

B

Bedford Foundry and Machine Co. 165
Bethlehem Steel Co. 39
Birdsboro Steel Foundry and Machine Co. 6
Blaw-Knox Co., Rolls Division 182
Bliss Co., E. W. 27
Bristol Co., The 168
Brooks Oil Co. 34
Browning and Co., Inc., Victor R. 18

C

C & D Batteries, Inc. 177
Cities Service Oil Co. 203
Clark Controller Co. 167
Clark Equipment Co., Ross Carrier Line, Industrial Truck Division 191
Cleveland Crane and Engineering Co. 48
Cleveland Quarries Co., The 175
Cleveland Worm and Gear Co. Cover 3
Columbia Electric Manufacturing Co. 178
Continental Foundry and Machine Co. Cover 1, 174
Corhart Refractories Co. 133
Crane Co. 150
Crouse-Hinds Co. 25
Cunningham Co., M. E. 178
Cutler-Hammer, Inc. Cover 2

D

De Laval Separator Co. 181
De Laval Steam Turbine Co. 146
Diamond Power Specialty Corp. 210
Documentation and Licenses, Paris, France 52
Dowell, Inc. 162
Drever Co. 19
Duraloy Co., The 172

E

Electric Controller and Manufacturing Co. 3, 127, 148
Elliott Co. 46, 47
Enterprise Co. 207

F

Farrel-Birmingham Co., Inc. 190
Flinn and Dreffein Engineering Co. 52
Foxboro Co., The 149

G

General Electric Co. 4, 5, 136
Gulf Oil Corp. 29
Guyan Machinery Co. 210

H

Hagan Corp. 12, 13
Hallden Machine Co., The 52
Harbison-Walker Refractories Co. 145
Heyl and Patterson, Inc. 45
Houghton and Co., E. F. 206
Hyatt Bearings Division, General Motors Corp. 128
Hyde Park Foundry and Machine Co. 177

J

Johns-Manville Corp. 26, 176

K

Koppers Co., Inc. 166, 180

L

Linde Air Products Co., Division of Union Carbide and Carbon Corp. 198
Link-Belt Co. 2, 189
Lintern Corp., The 178

M

Mackintosh-Hemphill Co. 135
Mannesmann-Meer Engineering and Construction Co. 40
Manning, Maxwell and Moore, Inc., Shaw Box Division 161
Matthews & Co., James H. 199
McKiernan Terry Corp. 212
Mesta Machine Co. 23
Metal and Thermit Corp. 209
Miles and Partner, John (London, Ltd.) 52
Minneapolis-Honeywell Regulator Co. 50, 51
Morgan Construction Co. 43
Morgan Engineering Co. 179

N

National Carbon Co., Division of Union Carbide and Carbon Corp. 20, 153, 154, 155, 156, 157, 158, 159, 160
Nelson Electric Manufacturing Co. 42

O

Ohio Steel Foundry 170
Okonite Co., The 202

P

Pennsylvania Transformer Co. 14
Pittsburgh Lectromelt Furnace Corp. 54
Poole Foundry and Machine Co. 37
Post-Glover Electric Co. 220
Pyle-National Co., The 199

R

Reliance Electric and Engineering Co. 201
Roberts and Schaefer Co. 173
Rockbestos Products Corp. 131
Rosedale Foundry and Machine Co. 208
Rowan Controller Co. 16
Rust Furnace Co. 125
Rust-Oleum Corp. 41

S

Sharples Corp., The 199
Simmons Machine Tool Corp. 169
Stamco, Inc. 33
Stearns Magnetic, Inc. 36
Sun Oil Co. 38

T

Taylor Chain Co., S. G. 178
Taylor Sons Co., The Charles 188
Texas Co., The Cover 4
Timken Roller Bearing Co., The 152
Torrington Co., The, Bantam Bearings Division 151
Trabon Engineering Corp. 204

U

Union Carbide and Carbon Corp., Linde Air Products Co. 198
United Engineering and Foundry Co. 17
United States Graphite Co. 32

W

Wagner Electric Corp. 185
Waterbury Farrel Foundry and Machine Co. 9
Wean Engineering Co. 52
Wean Engineering Co. of Canada, Ltd. 52
Wean Equipment Corp. 52
Westinghouse Electric Corp. 30, 31
Wilson Engineering Co., Inc., Lee 7

Y

Youngstown Alloy Casting Corp. 44
Youngstown Foundry and Machine Co., The 187

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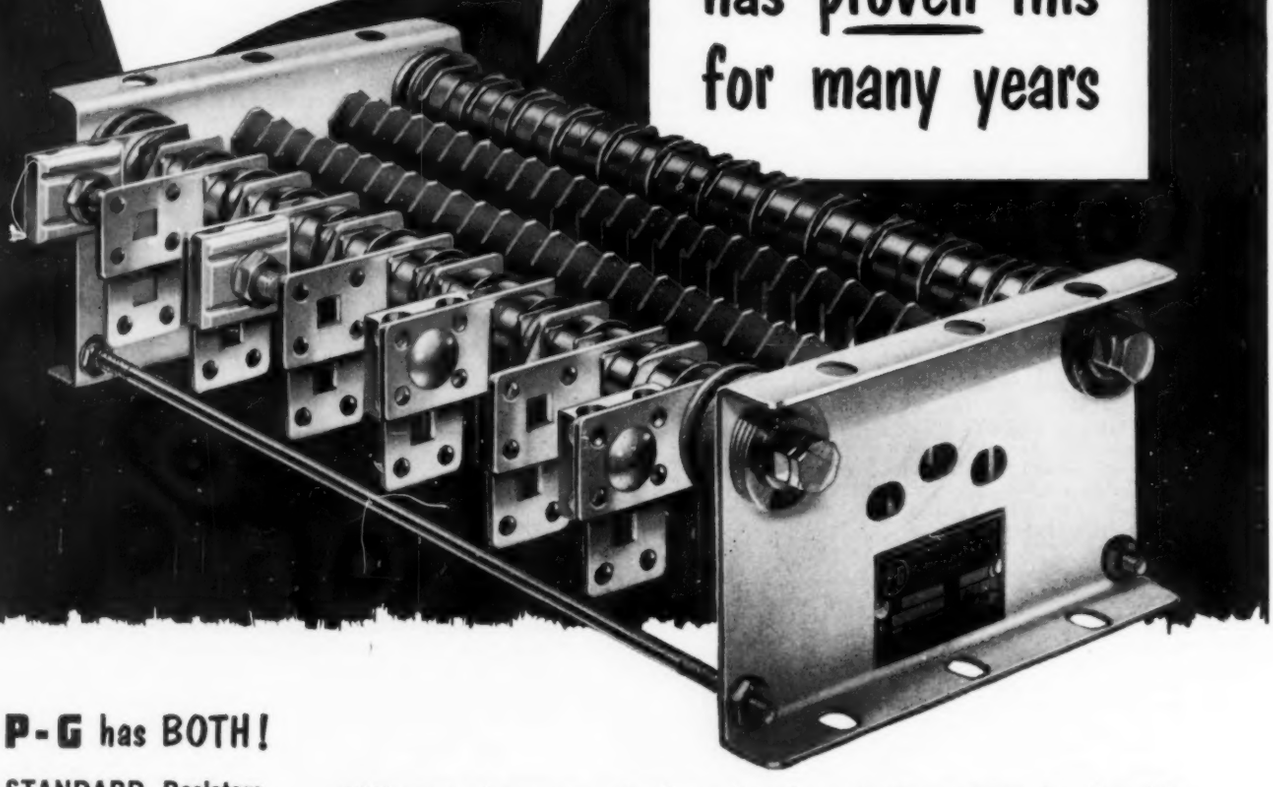

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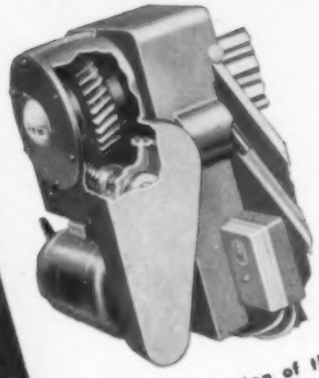

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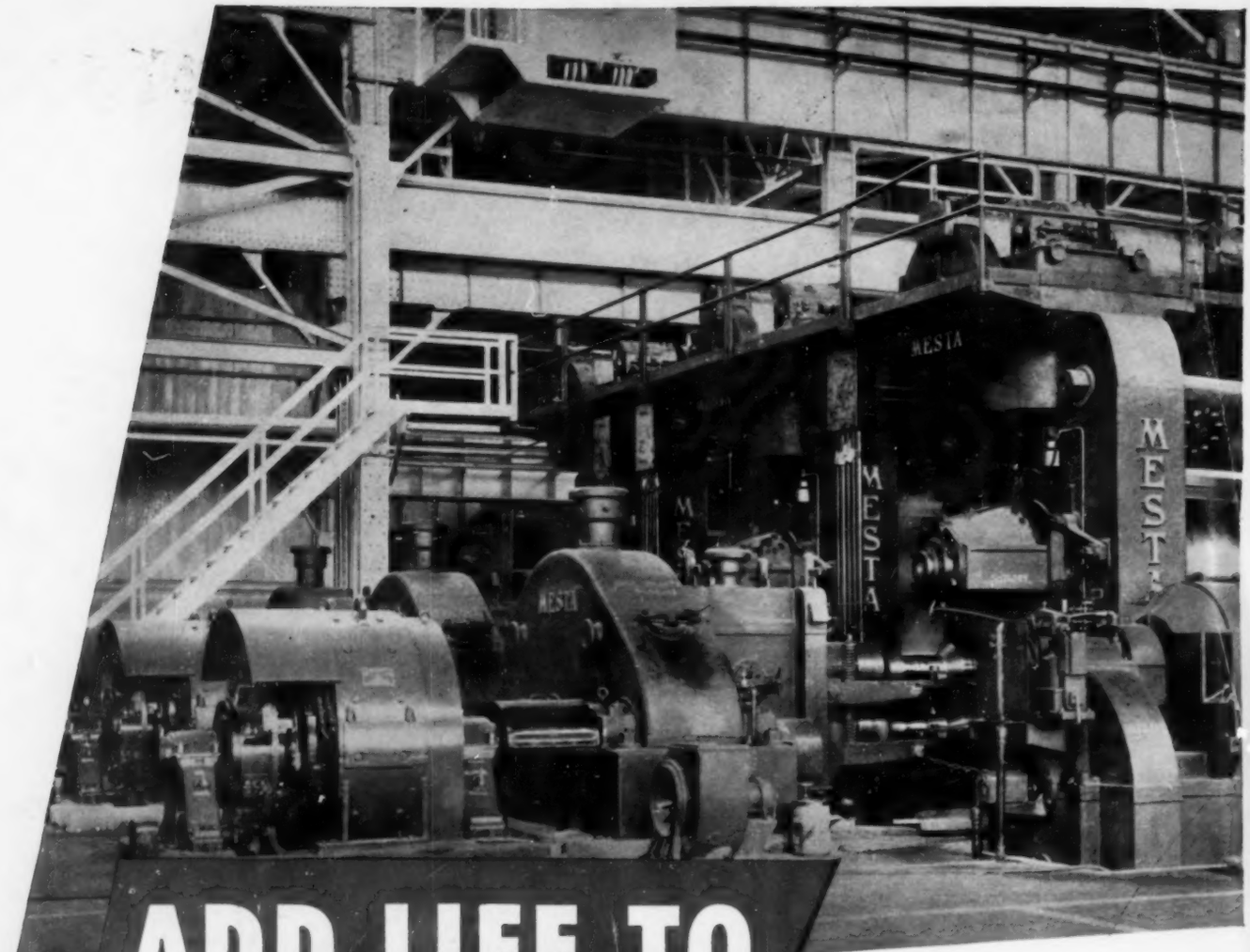

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